museums are in cities that are the capitals of distinct nations, and the local fields they have to illustrate are wider and less explored, while race patriotism is a stronger stimulus than county feeling. Municipal rivalry in this country may occasionally be keen, but the stimulating jealousy of the Italian cities cannot be rivalled elsewhere on this side of the Atlantic.

But allowing most generously for all this, there yet remains much that is not due to any such general cause. If we compare the amount of research turned out of the smaller German museums, with that executed by our own curators, many of whom have better libraries and material, we cannot but feel that a certain amount of blame rests with them. No doubt the provincial curators are burdened with many trivial duties, and so long as the few good museum appointments, such as those on the staff of officers of the Natural History Museum, are filled by promotion within that building, there are few chances of promotion, and little encouragement to originality or research. The provincial museums too often have no permanent scientific curator, and are entrusted either to volunteers or to men who have to look after them in the intervals of teaching or library work. The result is that the museum is not well kept, tablets get dusty, the labelling falls into arrears, and, as an aspect of untidiness pervades the place, it loses whatever attractions and educational value it may once have had. And this does not apply only to the smaller provincial towns: it was the Oxford Museum that an examination candidate once quoted as the authority for the statement that no insect had more than five legs, while the vast majority had only three.

The moment we attempt to consider what remedy can be found for this state of affairs, we are met by the initial difficulty as to what is the real ideal of a museum. At present opinions are certainly not settled as to whether museums are to be regarded as storehouses of material or as illustrated text-books. The former was for long allowed to hold the field, but during recent years the latter theory, stimulated by the Index Collections at the Natural History Museum, has steadily been gaining ground. The former is still held in Germany, while the Americans have in some cases carried the latter to the extremest limits, and the comparison of a German and American museum clearly illustrates the difference between the two.

The typical German provincial museum generally has an entrance through a back courtyard, the exhibition rooms are crowded with cases of different shapes and patterns, in which the greater proportion of the collection is exposed to view, and so the visitor easily finds the specimens that interest him. After sundry experiments the right keys are found, and as soon as twenty years' dust has been removed from the specimens he is able to set to work. But in the museums of the new style everything is different; the building is a handsome modern structure surrounded by a grass plot that would do credit to

the best rolled Oxford quad; the fittings are luxurious, the cases are beautifully French-polished and warranted dust-proof, and the rooms are scrupulously clean, thanks to an impressive proclamation in the entrance-hall, which decrees that neither "smoking, spitting, nor chewing are allowed on the premises." The mounting of the specimens is faultless, but the poor zoologist, who has hoped to see an extensive series of specimens of the same species or fauna, has to content himself with the examination of a few faultlessly-mounted specimens, including a crocodile, a lion, a giraffe, an elephant, a few other such curiosities, and a room of dissections of examination types. The museum has been converted into an elementary text-book illustrated by actual specimens or dissections, and in the absence of the responsible member of the staff, who, of course, takes his vacation at the time that the visitor has to take his, the latter leaves the museum no wiser than he entered it. In cases such as these, the museum has been run on lines that must ruin its value to systematic zoologists. No doubt the show collections are intended for general instruction, but to turn a large museum simply into a tool for teaching the terms and definitions of elementary biology is a reckless extravagance: this is the work of the school museum, whereas that of the large State Museum is to stimulate observation and general interest, and to aid the collector to identify his specimens by the display of adequate series of species and variations.

But in order to do this strict limitations are necessary on the collections housed in the museum, and the great fault of the English provincial museums is, as a rule, their miscellaneous nature; and this can only be prevented by the exercise of considerable tact and courage on the part of the curator. Professor Duncan used to tell a story of a gentleman who called on him one day, when he was re-arranging the Colchester Museum, and expressed such interest in the collection that he would be delighted to present to it a specimen of an 18 ft. crocodile. "Oh! no doubt you would, if it is 18 ft. long," was the opening sentence of the reply, in which the offer was gratefully declined. Unfortunately, this view of the aims of a provincial museum has not been always acted upon, with the result that in many cases the collection better illustrates the travels of the local gentry than the natural history of the neighbourhood. But the necessity for emphasising this view of the case is no longer necessary; the idea that a museum is intended as a mere "raree show" has long since been past. The educational value of museums is rapidly becoming recognised, and with the spread of technical teaching the necessity for an increase in their number and efficiency will, doubtless, follow, just as the free libraries have followed the establishment of School Boards. At the same time, they will cease to be regarded as mere branches of the library, and under independent control will be free to improve as greatly as the Natural History Departments of the British Museum have done since they escaped from the thraldom

of subserviency to the National Library. This change, it must not be forgotten, was mainly due to the continued agitation of Sir R. Owen, and a general alteration in the museum system of the country cannot be expected until the provincial curators strive for it. Hitherto there has been little united action among museum authorities; the foundation of the Museums Association, however, is a step in the right direction, and if this but establish a stronger *esprit de corps* among curators and stimulate them to use present opportunities more efficiently, it cannot but lead to the museums being placed on a sounder basis in the future.

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## The Deep-Sea Deposits of the West Indies.

Ever since the return of the "Challenger" Expedition first gave us a clear idea of the nature and distribution of the deep-sea deposits, no argument seems to have told so strongly for the theory of the permanence of oceans and continents than the asserted entire absence of deep-sea deposits among the marine sediments that have been raised above the sea. Various objections have been at times raised to this argument, but a first adequate reply to it has now been made by the publication of detailed descriptions of beds in Barbados which are claimed as of truly deep-sea origin by Haeckel, Jukes-Browne, and Harrison. Haeckel, in his "Challenger" Report on the Radiolaria, remarked that the Radiolaria of these deposits resembled those of the deepest areas of the Pacific. Jukes-Browne and Harrison, from a geological examination of the beds, maintained in letters to *Nature* that they were identical with deep-sea oozes, while the same conclusions were urged by Gregory on the evidence of an Echinoid having abyssal affinities obtained from the radiolarian deposits. The last number of the *Quart. Journ. Geol. Soc.* now contains two more papers bearing on the same subject. The principal of these is a detailed description by Messrs. Jukes-Browne and Harrison of the beds, giving an elaborate account of their structure, chemical, microscopical, and lithological; it is claimed in the paper that the extensive series of rocks comprised in the "Oceanic Deposits" of that island afford a complete parallel to the oozes of the present ocean floors: they include representatives of ordinary chalky earths, of radiolarian and diatomaceous oozes, and red clays. The lithological evidence shows that these are identical with modern deep-sea deposits, while the evidence of all the fossils known, including radiolaria as affirmed by Haeckel, of the Foraminifera as affirmed by Brady, and of the one echinoid as interpreted by Gregory, is in full agreement with this view. As these deep-sea beds are there interbedded between shallow water sandstones, and coral rocks, it affords evidence of a complete interchange of continental and oceanic conditions in late Tertiary times. Moreover, these beds do not only occur at Barbados; a pteropod marl indicates a fairly deep-water condition

at approximately the same period in Jamaica, while in the heart of the West Indian area radiolarian beds identical in character with those of Barbados have been found. Similarly, at the last meeting of the Geological Society, a paper by R. J. L. Guppy was read, describing the stratigraphical relations of a similar set of beds in Trinidad, and an appendix by Gregory describing the microscopic structure of the rocks shows that there again we have true oceanic deposits. This conclusion was strongly supported by Dr. Hinde, who had made a careful examination of the rocks. Geologists may, therefore, now fairly claim to have answered the challenge to produce deep-sea oozes as part of the raised land masses.

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### Another Continental Oceanic Deposit.

The last number of the zoological series of the Linnean Society's Journal is devoted to a description of the sponge remains from the Oamaru deposits in New Zealand, by Dr. G. J. Hinde and Mr. W. M. Holmes. The diatoms of this locality have long been known to microscopists, and have been described in a series of papers by Messrs. Grove and Sturt, published by the Quekett Club. The interest of this deposit is due largely to the fact that it appears to be a truly deep-sea pelagic deposit, and thus forms an additional illustration of the alternation of pelagic and continental conditions. The authors remark (p. 179): "The absence of coarse arenaceous materials is the same in the Oamaru as in the recent deep-sea ooze. We may therefore conclude that this Oamaru rock was a deep-sea deposit, formed at some considerable distance from land, and that it may rightly be compared with the Diatom ooze which now forms a belt of varying width surrounding the South Polar Regions, and extending from the Antarctic Circle to about lat. 40° S." The average depth of this diatom ooze is 1,477 fathoms, but the authors think the Oamaru deposit was formerly in deeper water than this, as radiolaria are so abundant in it; they think that its closest analogue is some ooze dredged by H.M.S. "Egeria," between 2,479 and 3,000 fathoms, off the south-west coast of Australia. The sponges described belong to 110 species and 43 genera, and this, of course, excludes those of which the flesh spicules have not been found. The species are nearly all extinct, and the deposit is probably to be regarded as of Upper Eocene or Oligocene age. Species of the group Monactinellida preponderate, whereas in the Mesozoic sponge beds this is almost unrepresented: this the authors regard as another instance of the imperfection of the geological record, the smaller monactinellid spicules having been rendered unrecognisable during the processes of fossilisation. In the course of such a careful examination of so large a series of specimens and species as that in the present memoir, numerous anomalies of distribution have been noticed: thus, genera known only living in the Central Atlantic

occur in the deposit, while genera which inhabit abyssal depths are associated with others now restricted to shallow seas. The authors of this careful and detailed monograph are to be congratulated on the combination of accurate systematic diagnosis, with a full consideration of the affinities of the fauna. The plates are of exceptional merit.

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## Epping Flora.

In the pamphlet on the "Organisation of Science," which we noticed last month, the author empties the vials of his contempt upon the compilers of county floras, which he calls "a kind of drivel over which life, and time, and print, are wasted." The author seems to forget that if naturalists are born, not made, it is collecting that has a good deal to do with the bearing: most men begin as collectors, and if this work is to be discouraged as waste of time, the next generation of naturalists is likely to be much smaller than the present. Except with those who agree with the writer of that pamphlet, we think most naturalists would strongly disapprove of the planting of wild plants from one district in the few small tracts of virgin land we have. We notice in the last number of the *Essex Naturalist* that *Damesonia* has recently been found in a very well known pond in Epping Forest.

> "The thing is neither so very fine nor rare;
> But the question how the devil it got there"

is a problem that is seriously puzzling the botanists of the Essex Field Club. There can be no doubt that such a plant as *Damesonia* (better known by its later name of *Actinocarpus*) could not possibly have escaped notice, while it is difficult to see how its introduction can have been effected by natural agencies. On the whole, one is bound to conclude that a too enthusiastic member of some acclimatisation society must have planted it there. If this sort of thing were done extensively it would hopelessly destroy the interest in the distribution of our native plants, which is the principal incentive to study among a large class of local workers. If this be the true explanation of this case, if the Epping botanists could only find out the man who has helped to muddle up the Forest record, that pond would probably receive an addition to its fauna as well as its flora.

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## The Dearth of Specialists.

In March and May we referred to Mr. F. Du Cane Godman's remarks on the increasing difficulty of obtaining specialists to undertake the work of describing many groups of insects. Mr. Whymper's "Travels amongst the Great Andes of the Equator," of which a second edition is in the press, affords an illustration of this difficulty, for though the expedition was made twelve years ago, the supple-

mentary volume in which the zoological collections are described has been issued with several large groups of insects omitted, as no one has been found able to describe them.

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British Association.

The 62nd Annual Meeting of the British Association is to be held at Edinburgh, commencing August 3.

Geology on this occasion receives especial honour in the person of the President, and rightly so. The Science of the Association is now divided into eight sections, and during the 61 meetings Geology has been represented seven times; by Buckland, Sedgwick, Murchison, Lyell, Phillips, Ramsay, and Dawson. Now the Presidential chair is to be occupied by Sir Archibald Geikie.

The cities and towns where meetings have been held include 22 in England, four in Scotland, three in Ireland, two in Wales, and one in Canada. Birmingham has on four occasions received the Association, in this respect standing alone. There are, however, many large English towns that at present remain unvisited, partly, it may be, on account of a lack of local scientific enterprise, and partly on account of the difficulty in finding accommodation, or in raising the funds necessary to offer a fitting reception.

Among these towns we may mention the following, all of which have a population above that of Exeter, one of the cities to which a very pleasant visit has been made. We give these in order, beginning with the lesser populations:—Darlington, Lincoln, Worcester, Burton-on-Trent, Hastings, Newport, Northampton, Reading, Halifax, Burnley, Carlisle, Huddersfield, Derby, Preston, Bolton, Blackburn, Oldham, Sunderland, Leicester, and Portsmouth. Other towns of importance might be mentioned, but some of these, like Wolverhampton, are situated very near to larger towns that have accorded a welcome to the British Association.

The following Presidents of the several Sections for the Edinburgh meeting have been elected:—A. Mathematical and Physical Science, Professor Arthur Schuster; B. Chemistry and Mineralogy, Professor Herbert McLeod; C. Geology, Professor Charles Lapworth; D. Biology, Professor W. Rutherford; E. Geography, Professor James Geikie; F. Economic Science and Statistics, The Hon. Sir C. W. Fremantle, K.C.B.; G. Mechanical Science, Professor W. C. Unwin; and H. Anthropology, Professor Alexander Macalister.

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The Seychelles, their Land Tortoises and Turtles.

Probably the most interesting of the Annual Colonial Reports issued this year is No. 40 [C. 6563, price 3*d*.], Mauritius (Seychelles and Rodrigues), which contains a Report on the Islands of Aldabra,

one of the Seychelles group. The report was written at the request of the Governor, by Thomas James Spurs, the lessee, who takes considerable interest in the structure of the island and in the preservation of its fauna and flora. Mr. Spurs remarks on the more abundant vegetation of Aldabra, compared with Astore, Cosmoledo, or Assumption. The island is covered with trees and stunted shrubs, is very green, and contains mangroves as much as 55 feet in height. As, however, the bush is inhabited by myriads of mosquitoes, few venture therein. Aldabra is flat, 20 miles long, trending north-west to south-east; its shape is crescentic, and a line of three islands between the horns encloses a lagoon, access to which is only obtained at low water by one of the four channels. The narrowness of the channel and the strength of the currents render it practicable only for steamers. In some valuable notes on the structure of Aldabra, Mr. Spurs says at first sight it seems extraordinary that an island essentially madreporic, and so vast, should not be interspersed with sandy plains; when, however, it is known how strong the currents and surf are, it is easily explained. The sea, bursting with great violence on the reef, has swept off all the calcareous detritus, and imparted to the growing coral an extraordinary strength. Mr. Spurs notes that the predominating coral in Aldabra is a great "porite"; he has not found it in the other islands, and has been unable to find it in a living state. The decomposition of the coral rock yields a yellow mould of great fertility, but, unfortunately, there is very little of it. The writer laments the destruction of the larger trees, which he considers partly due to the hurricane of 1889, and mainly to the mephitic exhalations from the soil. He quotes a note of Commander Needham's, written in 1890, as to the "rising of jets of vapour of large quantity from the water, which appeared around it to be depressed as in a whirlpool," and goes on to state that "the inference is that Aldabra is still liable to volcanic action." After some interesting meteorological notes, Mr. Spurs remarks that thirty species of trees and shrubs exist, but all are of small size, as they hardly find sufficient nourishment. Of the fauna, the large tortoises were very numerous, but owing to the reckless destruction by the harpooners, they have diminished in numbers. Referring to Picard Island, the writer has taken means to restock the place and to destroy the rats, which are the greatest enemies of young tortoises. He remarks on the activity and swiftness of these great chelonia, and says that they retire to the bush from May to September, and come out in October with the first rain. It is then that they couple, and the female lays from six to eight eggs in November, in January, and in February.

The sea turtles are numerous, but the males alone inhabit the bay. As soon as a female has attained the age of producing (20 to 25 years) she disappears—whither no one knows. When they return to the coast to lay eggs, they are covered with barnacles of two or three weeks' growth. The females are more valuable than

the males, and more easily caught, so much so that the proportion is ten males to one female, though ten females are hatched for every male. The males fight desperately in the breeding season, to the great advantage of the sharks, which as they are too small to eat a big turtle, eat only the fins, head, and tail, though one specimen caught by Mr. Spurs had a turtle inside of the weight of 30 lbs. The female turtle lays three times in each season, each time about 125 eggs. When hatched, the young fall a prey to land crabs, grallics, and frigate birds, and when they reach the sea, they allow themselves to be carried out by the currents into deep water, for there they are better able to escape the grasp of the fish. Mr. Spurs complains of the recklessness of the harpooners, who throw at great and small indiscriminately, and states that the protective laws were made by those ignorant of the habits of the turtles. He predicts that if not amended and enforced, turtles will be extinct in the Seychelles in ten years.

In a short supplementary letter from T. Risley Griffiths, the administrator, it is pointed out that the natural difficulties of the country and the seclusive habits of the land tortoises render their extinction unlikely, and while not exactly agreeing with the possible extinction of the turtles, shows that the enforcement of laws against fishermen in the open sea or uninhabited land is almost impossible. This letter also points out that the seas around the Aldabra group contain large quantities of beche-de-mer (the trepang of the Malays), and that Mr. Spurs has taken some Chinese, who are experts at preparing this article of diet, to Aldabra, and hopes to open up a new branch of trade with the Chinese markets. Mr. Spurs told Mr. Griffiths that he also expected to secure some 12,000 green turtles a year, the meat of which he proposes to dry and ship.

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### The Revival of Dried Seedlings.

In the *Revue Générale de Botanique*, M. Gaston Bonnier gives an account of some interesting experiments on the revival of dried seedlings of wheat, bean, haricot bean, pea, and maize.

Eight lots of wheat of the last year's harvest, each containing fifty grains, and as comparable as possible, were soaked in water for a day. These lots were designated A, $A^1$, B, $B^1$, C, $C^1$, and D, $D^1$ respectively, and subjected to different treatment. A and $A^1$ were dried for two days, A at 35° C., $A^1$ at 85°; at the end of the time they had not lost weight. The rest were set to germinate on sawdust under a bell-glass. After two days B, $B^1$ were taken up and dried for two days, B at 35° C., $B^1$ at 85° C. The radicle of the seedlings was showing.

At the end of the third day, when three roots were visible, C and $C^1$ were removed, and dried for two days at 35° C. and 85° C. respectively.

The remaining lots, D, D[1], were similarly treated at the end of the fourth day, when the roots were well developed, and the plumule had attained a length of 5 mm.

After drying, ten specimens were removed from each lot, put aside in a dry place, and set to germinate five months afterwards (in the following March). The results were quite analogous to those obtained with the other seedlings. M. Bonnier found that all the seedlings dried at 85° had quite lost their germinating power, except twelve out of the forty comprising the lot A[1], and these produced very poor plants, of which eight ultimately perished.

Of the seedlings dried at 35°, thirty-four out of forty of B, two recovered, giving plants as vigorous as those produced normally from seed. Of C, twenty-eight out of the forty recovered, but the resulting plants were less vigorous than those from seed, and five ultimately perished; while of D, only twenty-one out of forty recovered, yielding poor plants, twelve of which ultimately perished. No recovery took place under the same conditions with plants further advanced.

We see, therefore, that the recovery after drying depends on the stage of development of the seedling, and also on the temperature at which it is dried. It is very interesting to note the length of time—several months—during which the state of suspended animation can be retained.

Beans germinated for eight to fifteen days at 14° C., and then dried for one day at 35°, were able to resume active life; but if dried longer at the same temperature until there was no more loss of weight, they did not recover.

In the case of the haricot, younger seedlings must be taken than with the bean to ensure recovery. On these M. Bonnier made some histological observations. Seeds were germinated for two days and then dried completely at 20°, 35°, 55°, and 85° respectively. On examination of sections of the cotyledons in glycerine, the aspect of the cells was very different in the different cases. As we should expect, the dessiccation had a much greater effect on the protoplasm than on the cell-membrane, or the starch or aleurone grains. In fact, in the seedling dried at 85° C., there was no sensible change in the thickness of the last three; but the grains were much more crowded against each other and the cell-wall by the shrinking of the protoplasm. Iodine has a similar effect on the starch grains in the seedlings dried at 20° C. or 85° C., while Zinc Chlor. Iodine or aniline Violet colours the membranes almost in the same way. The protoplasm dried at 85° is very strongly stained by aniline-violet, but scarcely at all at 20° C.; Carmine in water stains it immediately at 85° C., but not at all at 20° C. These simple tests, M. Bonnier suggests, might be used to examine the power of germination by means of reagents. It is evident that the water combined with or contained in the protoplasm plays the most important part in the passage from active life to the dormant stage, and *vice versâ*.

Seedling peas could be dried without death resulting in a more advanced stage than haricots. Thus, after germinating for ten days at 13° C., when the root and hypocotyl together measured 6 or 7 cm., four seedlings were dried for twenty-four hours at 35° C. They were then soaked in water and put in the ground, when all four revived, producing plants which flowered abundantly.

Some maize was germinated for twelve days at 15° C., when the root and hypocotyl on an average measured 2 cm. After drying for twenty-four hours at 35° C., two-fifths of the specimens recovered, but when dried at 85° C. there was no recovery.

M. Bonnier also studied the relations between the gases taken up and given off, and also the evolution of heat. He gives no account of the experiments, simply stating that the phenomena in the revived seedlings are analogous to those obtaining in the germination of seeds, except that the first period (during which the proportion between the gases is nearly equal to unity, and the heat disengaged is less than subsequently), is relatively abridged, especially in the more advanced stage of development at which the seedling was dried.

Finally, M. Bonnier made a cultural experiment. Peas were sown in a plot of land, and then allowed to dry in the sun. On burying them a little in the ground and watering them they all revived.

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## The Protection of Birds.

The following circular letter has been issued by Mr. W. A. Nicholson :—

"Sir,—The committee of the Norfolk and Norwich Naturalists' Society are very desirous of bringing under the notice of landowners and agriculturists the great desirability of affording more efficient protection to useful birds, particularly those which, as destroyers of vermin and injurious insects, render immense service to the farmer and the community at large. Frequent comments and letters have recently appeared in the public journals as to the disastrous effects resulting from the indiscriminate slaughter of many useful species, not only in this country, but also on the Continent, and it is hoped that the publicity given, and the attention drawn to the subject will lead to a more judicious course of action. The importance of this matter, in view of the great devastation caused by the plague of field voles (mice) in some parts of Scotland, and past experiences in Lincolnshire, cannot be overlooked, and the opinions of the Scotch farmers in the districts affected, quoted from the reports to the Board of Agriculture, point to the folly of destroying owls, hawks, and weasels. The barn owl, a true farmers' friend, is much persecuted, but a more useful bird, as a destroyer of vermin, does not exist. It has been computed, by competent observers, that when it has young it will bring a mouse to its nest every 12 or 15 minutes, and as many as 20 good-sized rats, perfectly fresh, have been counted in a single nest. A recent communication to the daily papers states that a nest containing five young ones, being taken and placed under a hen coop about a mile distant, no less than 24 rats, large and small, brought there by the parent birds,

were found lying outside the coop the following morning. The owlets were at once returned to the place from whence they were taken. The kestrel hawk, a great killer of mice, is another bird which merits protection, and it is much to be desired that game preservers would give their keepers stringent orders not to molest it. To such an extent is the destruction of our native birds carried on, that it is not improbable further legislation in the matter will be called for, and it is to be hoped the Board of Agriculture will continue to prosecute their inquiries into the pecuniary loss accruing from such destruction."

The *Revue Scientifique* records that the enthusiastic protector of birds in France, M. Xavier Raspail, has just issued a letter to the Minister of the Interior, pointing out how the laws against bird destruction are openly violated by farmers. He states that of 15,544 birds destroyed, some 13,000 of them are known to feed on insects. He points out especially that the cultivation of wheat is becoming less and less remunerative, and one of the causes is traceable to the destruction of larks, whose food largely consists of the larva of a beetle, *Agriotes striatus*, whose ravages to the roots of wheat are well known. Vine growers complain of the scarcity of bird life in the vineyards, and perhaps the very best method of compelling the obstinate to understand is to pit them against their more sensible brethren. The *Zoologist* for May reprints portions of Messrs. Dudgeon and Davidson's reports on the plague of field mice in Scotland. They are stated to be "swarming in millions," and the cause of the pest is definitely said "to be the destruction of the natural enemies of the voles—hawks, owls, weasels, &c., and it has been remarked that, where plantations are present, affording roosting for birds of prey, the districts in their vicinity are less seriously affected." And again, during a similar outbreak in 1875, large accumulations of the casts of owls, consisting of the fur and half digested skins of mice, were seen on every hand. The report is very convincing, and should be circulated broadcast throughout the country by those responsible for general agricultural prosperity. The subject is attracting attention in the proper quarter already, for it is stated that the Royal Agricultural Society are contemplating the appointment of an economic ornithologist.

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THE large number of 260 elephants have recently been captured in the Garo Hills by a party of hunters headed by Mr. Savi, superintendent of Keddahs at Dacca.

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As an instance of the sudden destruction of animal life, it is interesting to note that, on the occasion of some heavy rains in Texas recently, so much sediment was carried to the rivers and streams that the water became so thick as to kill the fish, which floated by thousands down the flood.

A CURIOUS instance of the decalcification of bones by the action of water from a peat bog is recorded by Messrs. E. R. Waite and P. F. Kendall in the June number of *The Naturalist*. The case is that of a Fallow Deer discovered last summer in the peat of Goole Moor, Yorkshire. The bones are quite pliable and elastic, and of a dark brown colour; and the teeth also are so light that they float in water. Remains of the hair were also found with the skeleton.

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DR. KÜKENTHAL has been led to undertake the researches just referred to by his detailed investigation of the Embryology and Comparative Anatomy of the Cetacea, on which he will shortly issue an elaborate work. He considers that the Whalebone Whales have been evolved from a group of land-quadrupeds quite distinct from that which gave rise to the Toothed Whales, Porpoises, &c. Moreover, he is of opinion that the great number of the teeth in these aquatic mammals is due to the splitting of the fewer many-cusped teeth that existed in their ancestors.

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THE pineal eye of vertebrates still continues to attract attention, and Dr. Carrington Purvis attempts to criticise some current views in a brief paper on the pineal body of the Porbeagle Shark (*Lamna cornubica*) in the newly-issued part of the *Proceedings of the Royal Physical Society of Edinburgh* (Session 1890–91, pp. 62–67, pl. ii.). Dr. Purvis suspects, from his observations, that the conclusions of previous observers as to the pineal eye being comparable with a highly-developed invertebrate eye, will prove unfounded. He is inclined to think that it may be "a vertebrate type of eye, arrested, however, at a very early stage (primary optic vesicle stage) in its development."

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THE last number (30) of the *Bulletin of the Botanical Department of Jamaica* (April, 1892) contains the economics of the moth *Diatreea saccharalis*, Fabr., the sugar-cane borer, by T. D. A. Cockerell. After a brief historical note, which shows that the larva was probably that one referred to by Sir Hans Sloane as early as 1725, and that the imago was identified by Westwood in 1856 as the *Phaleena saccharalis* of Fabricius, 1793, the author notes the life-history of the insect from the egg to the moth, which has been figured by Comstock and Howard. The eggs are laid on the leaves of the young cane near the axils, and the larva penetrates the stalk at or near the joint, tunnelling through the soft pith usually in an upward direction. The whole life of the insect, from egg to moth, may be taken at six weeks. Little is known of the natural enemies of the sugar-cane borer, but ants have been observed to keep it in check. *Chanliognathus pennsylvanicus*, in its larval stage, has been seen feeding on larvæ of

*Diatræa*. The notes on geographical distribution seem to point to a wide range; West Indies, United States, Sandwich Isles, India, and Queensland, are mentioned. The injury done by the larva is very serious; in one case a grower writes, "we had estimated for 140 tons, but will not make more than 115 tons of sugar," a reduction probably resulting in loss instead of profit. The larva of *Diatræa* has been found to attack maize, sorghum and gama grass, and as Mr. Cockerell points out, "the occurrence of the borer in a wild grass may be of considerable practical importance, as it would be almost useless to kill the borers in the canes if they were breeding abundantly in an adjoining grass-patch." Of the remedies, the most effective seems to be that of burning the waste upon the plantation itself, though Paris green, carbolic acid, sulphate of ammonia, kerosene, have all been serviceable. A fertiliser called "Kainit" seems to be protective, and has the additional advantage of improving the soil for future crops. Some remarks on species allied to the sugar-cane borer, and on some other sugar-cane pests, complete a careful paper, which, from the fact that the author has collected together the writings of his predecessors on the subject, and added to them many personal observations, should prove of much value to growers of this plant.

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THE imports of raw caoutchouc and raw gutta percha into the United Kingdom for the past seven years, occupies the *Supplement to the India Rubber Journal* for 9th May. The article gives the weight imported per month, its value, and the localities from which it is obtained. We notice that, as regards caoutchouc, the import steadily increases, while the import of gutta percha varies considerably from year to year. The price of the latter has risen rapidly the last few years.

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ENGLISH grown tobacco was, we believe, not a success, and English grown tea will probably never be more than a curiosity. However, Mr. W. Iceton has recently reared a number of the latter plants in his palm nurseries at Putney, and Mr. John Roger, formerly a Ceylon tea planter, has prepared tea from them. The plants and the economic product were exhibited at Exeter Hall at a recent meeting, and the Princess Louise and the Marquis of Lorne, who were present, were regaled with the beverage. Mr. Roger believes this to be the first preparation of tea from the home-grown leaf.

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IN the June number of *Grevillea* Dr. M. C. Cooke takes leave of the subscribers to the journal, which he has directed and edited from its commencement twenty years ago. Increasing years and fickle health are the reasons for transferring the duties and responsibilities to other and younger hands; but Dr. Cooke does not intend to "sever

his interest" or "withhold the use of his pen." Mr. George Massee undertakes the responsibility of carrying on the work, and will endeavour "to accomplish the desire expressed by the editor in the first volume; that of describing or recording new discoveries—especially British—in every section of Cryptogamic Botany, also, by abstracts and notices, to indicate the results of work done in other countries, biological, morphological, and systematic." Assistance has been promised by well-known specialists, and Mr. E. A. L. Batters will take entire charge of the section devoted to Algæ. We are glad to notice that each number is to contain "one or two plates, plain or coloured, as occasion may require."

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In a preliminary note on the Foraminifera dredged by the Prince of Monaco off the Azores, contributed to the *Mém. Soc. Zool. France* (vol. v., 1892, p. 193), M. Schlumberger describes and figures for the first time the young free stage of *Polytrema miniaceum* (Linn.). A median section shows an assemblage of three spherical chambers having thin walls pierced with few perforations, and arranged as the embryonic chambers of a *Globigerina*, except that there are no special openings from one chamber to the other. Around these three chambers are numerous others, irregular in size, and presenting the adult exterior characters of *Polytrema*. M. Schlumberger adds that the embryonic form may be found in adult specimens, a little above the surface of attachment.

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M. E. L. Bouvier has published some observations on the power of Hermit Crabs to adapt themselves when young indiscriminately to left-handed and right-handed Gasteropod shells (*Bull. Soc. Philom. Paris*, ser. 8, vol. iv., pp. 5–9, 1892). He concludes that the majority become adapted to the right-handed twist, because shells of this character are by far the most numerous. When immature, the crabs seem to be indifferent as to the direction of the twist, though, as already remarked by A. Agassiz, there is a tendency in the abdomen to curve to the right even in very young individuals that have not yet dwelt in a shell.

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The mode of formation of the well-known chitinous envelope of the larvæ of Dragon-flies (*Libellula*) has recently been investigated anew by M. Joannes Chatin (*Comptes Rendus*, vol. cxiv., pp. 1135–1138). Contrary to the prevailing belief that this covering arises as a secretion, M. Chatin concludes that it originates by the direct modification of the cells of the epidermis itself. The process as described is peculiar, and the results of the investigation, if confirmed, will necessitate some modification in current views as to the true nature of the skin in insects.

Two noteworthy contributions to knowledge of the Hydrozoan polypes have lately appeared. In studying the common *Hydra*, Dr. R. Zoja (*Rendiconti R. Istit. Lombardo* [2], vol. xxv., pp. 700–712, pl. iii.) has been led to interpret as evidence of a comparatively complex nervous system, certain groups of granules and radiating filaments, which he has been able to observe with great distinctness. In an elaborate memoir on *Ceratella* (*Trans. Roy. Soc. Victoria*, vol. ii., pt. ii., pp. 8–24, pls. ii.–iiiA.), Professor Baldwin Spencer supplements and completes the work of previous observers in describing the anatomy of this remarkable polype. Originally determined to be a sponge by Gray in 1868, *Ceratella* was first recognised as a Hydrozoan by H. J. Carter in 1873, and Professor Spencer now confirms the belief that it represents a family distinct from that of the Hydractiniidæ.

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THE supposed salivary glands of the "sea-mouse" (*Aphrodite*) have recently been examined by M. A. E. Malard, who points out that they are not in the least glandular in character, and ought to be regarded as labial palpi (*Bull. Soc. Philom. Paris*, ser. 8, vol. iv., pp. 15, 16).

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IN describing a new Staphylinid Beetle (*Trygaeus javanicus*) from Western Java (*Notes Leyden Mus.*, vol. xiv., 1892, p. 61), Dr. D. Sharp expresses his dissent from the current belief that the insect fauna of Japan is more similar to that of the Palæarctic region than to that of the Oriental region. He is of opinion that the belief is due solely to the imperfection of the evidence, and that when as much is known about the insects of the East as is already known about those of Europe, the fauna of Japan will be found to agree most closely with that of the Oriental region.

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THE Pharmaceutical Society have just published a Catalogue of the Hanbury Herbarium contained in their Museum at Bloomsbury Square. It forms a small octavo volume of about 150 pages, and is the work of Mr. E. M. Holmes, the Curator of the Museum. Mr. Daniel Hanbury's Pharmaceutical Herbarium and collection of Materia Medica were presented to the society by his executors, on the condition that they should be kept apart and carefully protected from injury or loss. As the specimens are, as a rule, excellently preserved, and complete in detail, they will doubtless, with the help of the catalogue, be of great service to students of pharmacy, who seem to have been in want of something of the kind.

The classification adopted is that of Bentham and Hooker's "Genera Plantarum," and the plants are arranged alphabetically under each natural order. Separate sheets of specimens are indicated by italic letters, and the specimens on each sheet by ordinary

numerals. The value of the Catalogue is much enhanced by the dates, localities, and references to published works included under each specimen, with frequently interesting notes on the history or properties of the plant in question.

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An important memoir on the Petroleum and Ozokerite of Galicia, by Mr. Boverton Redwood, appears in the *Journ. Soc. Chemical Industry* (vol. xi., No. 2). Petroleum occurs in the "Carpathian Sandstones," the upper member of which is Eocene, the lower being Neocomian; in the upper Eocene or Oligocene; and in the Miocene beds. Ozokerite is found in small quantities in the older strata, but the main deposits are in the Miocene of Boryslaw. This material is extracted by shafts; while the petroleum is pumped from bore-holes. The strata are much folded, and are sometimes slightly inverted. The more productive areas for petroleum are frequently along anticlinal folds. Mr. Redwood's memoir is rendered much more valuable by the addition of a general map of Europe, on which all the principal petroleum fields are marked.

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Something will happen to the President of the Royal Society, for has not Dr. Irving, in the June number of the *Geological Magazine*, remarked "there can be no necessity for pointing out the importance of this *dictum* from the pen of Lord Kelvin; it supports my own contention." It is not often that mortal man receives such a compliment as this.

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In our May number (p. 169) we announced that a Catalogue of the Gasteropoda of the Inferior Oolite would shortly be published by Mr. Hudleston; we should have stated that the work is the joint production of Mr. Hudleston and Mr. E. Wilson, and that it is a Catalogue of the British Jurassic Gasteropoda.

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The last part of the *Transactions of the Zoological Society* (vol. xiii., pp. 165–175, pl. xix., 1892) is devoted to a description by Mr. E. T. Newton of a finely-preserved skull of the gigantic extinct Beaver-like animal (*Trogontherium*) from the Forest-bed of the Norfolk Coast. As our readers are probably aware, the genus *Trogontherium* was originally described upon the evidence of a skull from the superficial deposits of Siberia described as long ago as the year 1809; and, although most of those entitled to speak with authority on the subject have been convinced of their identity, the remains of the giant beaver hitherto obtained from the Norfolk Forest-bed have been too imperfect to render it absolutely certain that they belonged to the same species as the Siberian animal. The skull now so ably described by Mr. Newton

is thus an opportune "find." As the result of an exhaustive examination, the author is convinced that not only is the Forest-bed animal specifically identical with the Trogonthere, but likewise with the creature found in the Upper Tertiary of St. Prest, in France, and described under the name of *Conodontes*. Mr. Newton is also careful to indicate the points in which the skull of the Trogonthere differs from that of the true Beaver (*Castor*); and the points of distinction are so great as to leave no manner of doubt as to the right of the two forms to be at least generically separated. The reason why a widely-distributed animal like the Trogonthere, apparently as well fitted to survive as its contemporaries the Beaver and the Desman, has become extinct, is not yet apparent.

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THE scope for the operation of the principle of Natural Selection in a group of organisms so lowly as the Bacteria, may at first sight appear somewhat limited; but in an article just published by Professor G. Canestrini in the *Bull. Soc. Veneto-Trent. Sci. Nat.* (vol. v., pp. 85–100), the author points out that the range of possible variation is not so restricted as might be supposed. In the first place, the diminution in size of the organisms may count as an advantage; and the possible modes and manners of locomotion are sufficiently multifarious. The varying development of protective membranes and capsules may, in the Professor's opinion, afford much scope for the effective agency of Natural Selection—and so also may the numerous variations in the form, size, and capability of resistance of the spores. On the whole, it seems probable that Bacteria originated primitively as organisms living in the air; and, if that be the case, there are thus endless possibilities of modification (at least physiologically) as they become adapted for life respectively in animal tissues or fermenting and putrefying liquids. In any case, whatever be the *modus operandi* of the evolution, remarkable new forms are continually being discovered, and attention may be particularly directed to the newly-established genus *Nevskia*, found by Dr. A. Famintzine in the aquarium of the Botanical Laboratory of the Imperial Academy at St. Petersburg (*Bull. Acad. Imp. Sci. St.-Pétersb.*, n.s., vol. ii., No. 3). *Nevskia ramosa* is believed by its discoverer to be the first representative among the Schizomycetes of the colony-forming organisms with branched processes, of which the corresponding forms have long been known among Algæ and Infusoria.

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THE "Société Scientifique du Chili," founded by a group of French residents in April, 1891, has issued the first fascicle of its "Actes." This is a work of 185 pages illustrated by 18 plates. The longest memoir is by M. F. Lataste, and is an "Etude sur la faune chilienne," and of it two parts have been issued dealing with the Lizards and Bats. The President of the Society, M. Obrecht,

contributes an interesting paper on the daily movements of the soil in Santiago, illustrated by 18 plates of diagrams. M. Philibert Germain describes a journey to Bolivia, in which he gives some interesting account of the Aymara Indians and the Lamas, and also gives a result of three months' work in the valley of Sipotuba, in the now revolted province of Matto Grosso. Some notes on the synonymy of some Chilian insects is the only paper published in Spanish. M. A. F. Nogués has a memoir on the "Genesis of Gold," than which no more appropriate subject for study could be found in a South American republic. The publications of the *Deutsche Verein im Santiago* are well known to all naturalists.

I.

# The Story of Olenellus.

THE trilobite *Olenellus*, after forty years of comparative seclusion, has of late attracted the attention of geologists to a degree almost unprecedented among invertebrate forms of life. It has given its name to a "zone" which, accepted though it is by Messrs. J. E. Marr and H. B. Woodward, seems none the less of vast proportions when compared with our ordinary conceptions of fossil zones; it takes the first rank in a fauna that includes 150 species of other genera; and it now absorbs our thoughts when we behold miles of apparently unfossiliferous strata, or when we examine, for the hundredth time, obscure organic markings treasured in our own collections. At the outset this unassuming creature bore other names than *Olenellus*; it was regarded as a family-dependent rather than as an ancestor; but in due time field-observation has raised it to the most honourable position.

When Dr. Ebenezer Emmons, in 1844 (1, p. 21), figured a flattened and imperfect trilobite, and named it *Elliptocephala asaphoides*, from the elliptical marking formed by the eyes and a part of the glabella, he could not have foreseen the wealth of literature to which his discovery would give rise. In fact, *Elliptocephala* and *Atops* were the first two forms described from the now famous Olenellus-fauna, and the historic site of their discovery has been fixed with precision as near Reynold's Inn, west of North Greenwich, Washington County, New York State (19, p. 638). *Atops* as a genus has disappeared, and *Elliptocephala* was speedily absorbed into *Olenus* (Hall, 2, p. 256); but its lustre was only temporarily dimmed. After describing *Olenus thompsoni* and *Olenus vermontana*, from the shales of the Hudson River series at Georgia, Vermont (4, p. 60), James Hall published a revised figure of the former, accompanied by a restoration, and redescribed the species as the type of a new genus, *Barrandia* (5, p. 115). The species *vermontana* became also included in this genus; but its full beauty was unknown till later, earth-stresses having harshly dealt with the original, curtailing it of 19 segments. *Barrandia* was thus defined as possessing only 13 or 14 thoracic segments; but the great development of the third segment was rightly made a character distinguishing it from *Olenus*. Curiously enough, this feature is shown in Emmons's original figure of *Elliptocephala*

*asaphoides*, though it is not referred to by him; and this species seems to have remained as an *Olenus* until Ford investigated it in 1871 (7, p. 33, and 10, p. 257). Hall, in establishing *Barrandia*, insisted upon the form of the glabella, of nearly equal width throughout, and upon the narrow elongated pygidium, and commented on the difficulty of determining the facial sutures. Two years later (6) he found that the name *Barrandia* was pre-occupied, and reverted to what had been, indeed, his first conception, *Olenellus*.

Here, then, we have, in 1862, two well described species referred to the genus *Olenellus;* what was known as to their horizon? It was generally believed that the beds of Georgia in Vermont, with presumably corresponding strata on the Belle Isle Straits in Newfoundland, were above the horizons containing *Paradoxides*, and were referable alike to some part of the Potsdam series. The Georgia beds thus remained as Upper or Middle Cambrian until 1888, and the palæontological history of *Olenellus* is in consequence full of an unconscious humour. Hall (5, p. 115) prophetically remarked that "these forms"—*O. thompsoni* and *vermontana*—"will be found to mark an important horizon in our geological series," but this was on account of their association "with other forms that indicate the last appearance and final dying out of the types of that ancient crustacean fauna which marked, so far as we now know, the dawn of life upon our planet."

Mr. S. W. Ford (7) gave *Olenellus* additional interest by his researches among the rocks of New York State, and Brögger (8) observed of the Scandinavian *Paradoxides kjerulfi* that it seemed "significantly related to the American Cambrian species *P. thompsoni*"—the typical *Olenellus* of Hall. This apparently simple remark was the foundation, seventeen years ago, of the present high cult of *Olenellus;* it was taken up by Linnarsson (9), who emphasised the difficulty of seeing facial sutures in *P. kjerulfi;* and finally by Holm (13), who removed this species to *Olenellus*.

Meanwhile, Ford and Walcott in America fell into a trap that nature had provided for them, or rather remained in it unsuspectingly. The former (10, p. 256), treating of the old *Olenellus asaphoides* of Emmons, observed that it "may be safely regarded as higher in grade than any known form of *Paradoxides* whatsoever," and he preferred to keep it generically distinct from *Paradoxides kjerulfi*, which he looked on as its probable ancestor. His paper is eminently unassuming and fair-minded in tone; it leads from the small to the great, from the concrete to the abstract, from embryo-trilobites to the principles of descent; and it might be urged that here indeed we have zoological considerations confirming the work of the field-surveyor. Those who would absorb palæontology into zoology, instead of regarding it as a mutually helpful meeting-ground, might feel that William Smith's methods, based on laborious outdoor observation, were destined to find a formidable rival in the established principles of embryology.

Walcott (11, p. 166) assented to Ford's argument, remarking that *Olenellus* "expresses, in one of its species at least, the decadence" of the *Paradoxides* type. But he frankly admitted that *Olenellus gilberti* showed a permanent retention and great development of what were regarded as embryonic characters, and he accordingly recognised in this species a "retrogression." In the same paper an admirable amount of work is published on the Olenellus-fauna, regarded as Middle Cambrian; and a new genus, *Mesonacis* (11, p. 158), is put forward for *Olenellus vermontana* (Fig. 2), which now rejoices in its full 26 thoracic segments and a broad, not styliform, pygidium.

Into this scene of zoological and geological contentment Dr. Brögger suddenly discharged a bomb-shell. In a remarkable paper (12) on the Olenellus-zone in N. America, he pointed out that in Europe *Olenellus* preceded *Paradoxides*, and urged that, from a comparison of the faunas, made possible by the extensive work of Walcott, there was "no reasonable doubt" that the Olenellus-zone in America was also on the lowest level. Walcott, finding the New York area still difficult of interpretation, at once pushed his researches to Newfoundland, and gave us the complete section, in unbroken and undisturbed strata (14), at Manuel's Brook, Conception Bay. The American sequence straightened itself out; the Lower Cambrian of the Hudson River was shown to have been thrust by a profound fault over on to the Ordovician rocks (19, p. 526); and we have now the beds of Georgia, Vermont, with *Olenellus*, as Lower Cambrian; the St. John and Avalon beds, with *Paradoxides*, as Middle Cambrian; and the Potsdam and Belle Isle beds, with *Dikellocephalus* and *Olenus*, as Upper Cambrian. The basement-bed at Manuel's Brook is a coarse conglomerate, and rests directly upon "Algonkian" gneiss. Thanks to the intercommunication made possible by scientific journals, the work of Brögger and Holm in Scandinavia, and of Schmidt in Russia, thus rapidly bore fruit in North America; and *Olenellus* assumed its place as marking the earliest known fauna of the globe. The next fauna that may be found below it—and hints of this are already darkly scattered (22)—will be of true Precambrian age.

The triumph was to William Smith, a man grossly ignorant of phylogeny;[1] it only remained to re-explain the relationship of *Olenellus* and *Paradoxides* (16, p. 39). The child had proved to be the father; and the arguments in the contrary direction have been readjusted to everyone's satisfaction. It is a case of

"By the Lord, I knew ye, as well as he that made ye."

After this, we can only admire the courage of Messrs. Peach and Horne (24, p. 240) in suggesting that *Olenellus* is the central point in which the more modern trilobites, the Limuloids, and the Merostomata, converge.

[1] See his "Stratigraphical System of Organised Fossils," 1817, p. vii.

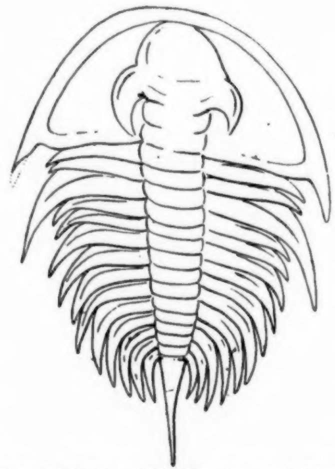

FIG. 1.—Outline of *Olenellus thompsoni*, Hall Parker's Quarry, Georgia township, Vermont. (After Walcott; size not stated.)

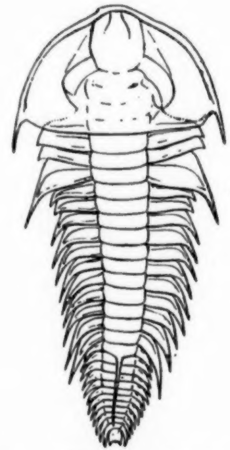

FIG. 2.—Outline of *Olenellus (Mesonacis) vermontana*, Hall Same locality. (After Walcott; size not stated.)

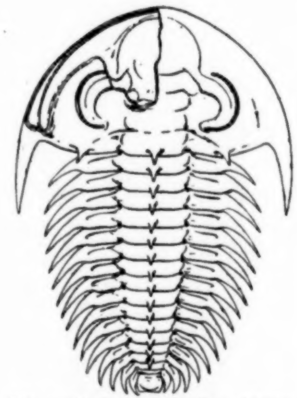

FIG. 3.—Outline of *Olenellus (Holmia) kjerulfi*, Linnarsson. Tomten, parish of Ringsaker, Norway. (Restoration, after Holm; × 1½. The hypostome is shown by removal of part of the head-shield; the glabella in *Holmia callavei* is distinctly narrowed in front.

Walcott, in his last great work on the Olenellus-fauna (19), abstains, somewhat generously, from breaking up this important genus; and most workers will approve his action in the present state of knowledge. Messrs. Peach and Horne (24, p. 236) also give a clear grouping of the eleven species already known. Whether *Olenellus* proper, *Mesonacis*, or *Holmia* (18), we find in all a semi-circular head-shield, prolonged into long or short posterior spines; a glabella of nearly equal width throughout, but often narrowed in front; large eyes; and no true facial sutures. The number of thoracic segments becomes of little value, ranging from 13 to 26, and it is interesting to find the characteristic head-shield in conjunction with a styliform pygidium in *Olenellus* proper, and a Paradoxidian pygidium in *Mesonacis* and *Holmia*. The great development and frequent prolongation of the third thoracic segment is not a constant character in the same species, though its occurrence in any specimen suggests that we are dealing with *Olenellus*. The surface of the whole test is often seen to be ornamented by a network of fine lines enclosing polygonal spaces, so that even fragments may thus be recognised.

The above details would be beyond our present purpose but that the search for *Olenellus* has already assumed vigorous proportions. Professor Lapworth (15) in 1888 announced the first discovery of the genus in the British Isles, near the base of the Comley or Hollybush Sandstone, at the foot of Little Caradoc in Shropshire. The species, *O.* (*Holmia*) *callavei*, has been figured and restored (20), so as to be worthy of its Scandinavian rivals, which its large size, six inches by four inches, practically equals. Professor Lapworth unerringly predicted that the Durness series of Scotland might also reach down to the base of the Cambrians; and in 1891 Sir A. Geikie (22) announced the discovery of *Olenellus* in the North-West Highlands. Messrs. Peach and Horne have now (24) given us a full account of the occurrence of a new species, *O. lapworthi*, in dark shales at the top of the "Serpulite Grits," and also in the underlying "Fucoid Beds" (so named from fucoidal casts of worm-burrows) on the Loch an Nid river in the south of Dundonnell Forest, Ross-shire. The tourist was formerly denied access to this rugged deer-forest, and Professor Heddle's kindly meant description of it was sternly excised from the visitors' book at the neighbouring hotel; but perhaps now the hunters of an invertebrate fauna may occasionally gain admittance. The Geological Survey is fortunately free in this respect; and we now know that the "Serpulite Grit," the "Fucoid Beds," and the quartzite forming the base of the Durness series, some 680 feet in all, are of Lower Cambrian age, and that "the Precambrian age of the Torridon Sandstone necessarily follows, the quartzites being unconformable upon it."

It is noteworthy that when Professor Jas. Nicol (3) made his famous statement that the lower gneiss of the Scottish Highlands might have been forced up to form the apparently overlying eastern

gneiss, he still regarded the Torridon sandstones as Devonian; but Murchison soon after referred these enormous masses, the bulwark of the west highland coast, to the Cambrian System. Professor Judd has, we believe, in his teaching uniformly regarded them as Precambrian, an opinion now completely justified.

The Longmynd Series also gains in antiquity by the discovery of *Olenellus callavei* at a higher level; and it has been unhesitatingly placed as Precambrian by Professor Blake. Dr. Hicks (23) has claimed as *Olenellus*, from their characteristic surface-ornamentation, certain trilobitic remains from rocks some 3000 feet below the Menevian at St. David's; and he gives us in consequence a classification that may be stated thus:—

| | |
|---|---|
| Upper Cambrian | Tremadoc Series. |
| | Lingula Flag ,, |
| Middle Cambrian | Menevian ,, |
| | Solva ,, |
| Lower Cambrian | Caerfai ,, |

The triple palæontological division of the Cambrian into the *Olenellus*, *Paradoxides*, and *Olenus* zones is thus arranged for and accepted in Great Britain; Professor Lapworth (20, p. 533) would call the three divisions Taconian (the Olenellus-zone), Menevian (or Paradoxian) and Olenidian; and doubtless there will be some discussion and rectification of the limits of each division. Mr. Walcott (21, p. 376) already asks us to place half the Tremadoc Series in the Ordovician; and the story of *Olenellus*, so far as it has gone, is not calculated to give us confidence in a resting stage in classification. However grateful we may be for the literature showered on us, there is one severe critic (25) who would have preferred results to dissertations. The open country has been appealed to, the first and final arbiter in stratigraphical determination; discovery must precede discussion, and we are on the eve of notable discoveries in the Olenellus-beds of many lands. It is, after all, the Olenellus-fauna that should attract us, rather than any single genus; and its richness will be seen by all who examine Mr. Walcott's comprehensive memoir (19). We may in any case be sure that the roots of any genealogical trees that we may casually construct will be found to reach far down into yet more fascinating Precambrian zones.

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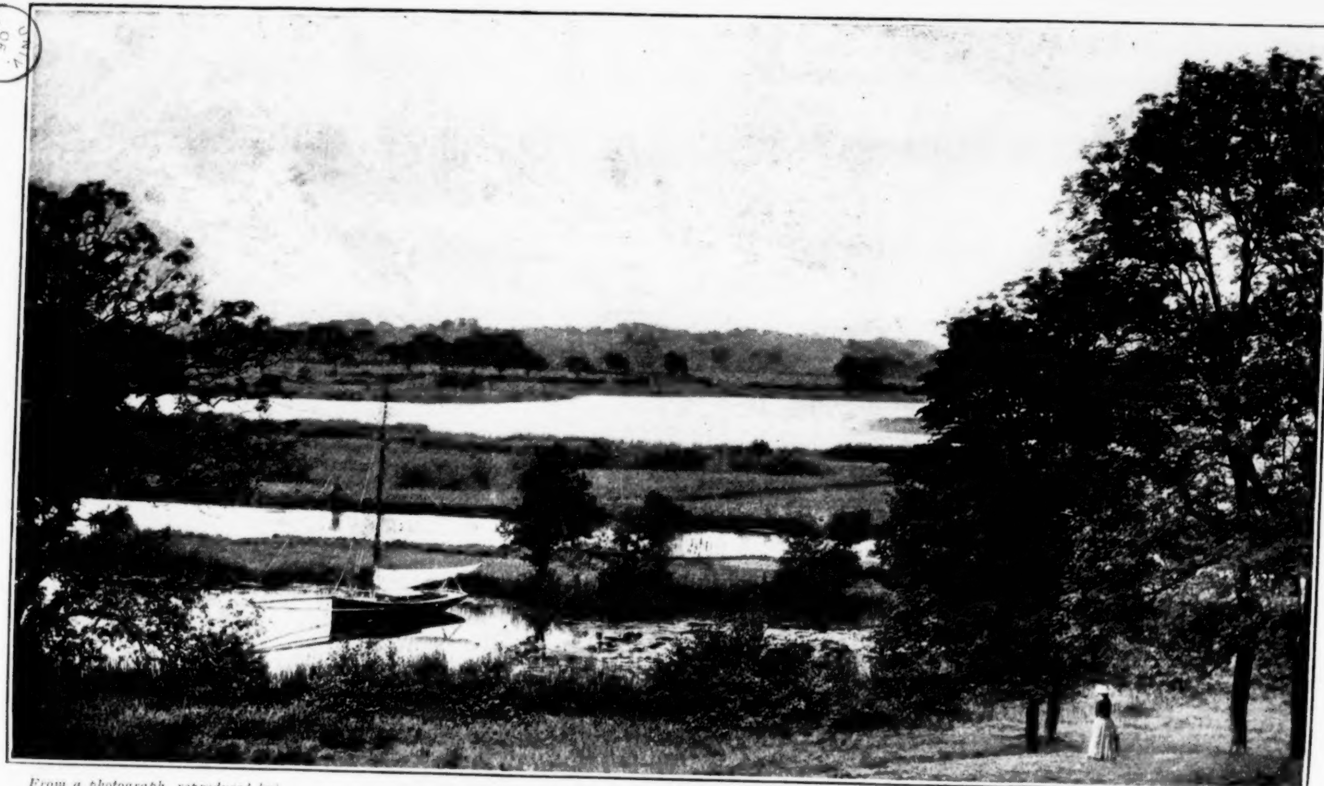
GRENVILLE A. J. COLE.



*From a photograph, reproduced by*] **HOVETON GREAT BROAD AND THE BURE.** [*kind permission of* PAYNE JENNINGS, ESQ.

The view is taken from the slope of the hills of Bure Valley Beds, capped by Glacial Drift, which form the southern margin of the valley of the Bure; the same beds are seen in the distance on the north side. In the immediate foreground is one arm of Salhouse Broad; the Bure flows between this and Hoveton Broad, from both of which it is separated by strips of "rand." The flat plain of alluvium marks the extent of the original Broad.

II.

# The Physical Features of the Norfolk Broads.

THE rivers that drain the eastern slope of England have, on the whole, a somewhat similar course; they rise on the eastern side of the series of hills that forms the main watershed of the country, they flow with a gradually decreasing gradient till they expand into a triangular estuary widely open to the sea. Such is the case with the Tees, Tyne, and Thames, and the rivers that unite to form the Humber and the Orwell, or that flow into the Wash. In the case, however, of the Yare, and its tributaries the Waveney and the Bure, which drain the region between the Fenlands and the Orwell, the conditions are very different: instead of the large, broad-mouthed estuaries, the entrance is very narrow, and the river expands behind into an extensive sheet of water. The shoaling, moreover, has not resulted in a series of long banks parallel to the main flow of the water, as in the Thames, or in broad flats of marsh either on the sides as in the Humber, or at the head as in the Wash; the rivers flow through tracts of land formed, at least in the upper part of the course, more by the growth of water-plants than by the actual deposition of mud or sand; and, finally, the rivers remain comparatively insignificant streams, while the main water area is formed by the isolated sheets now so well known as the Norfolk Broads.

That the area over which these are distributed was once an estuary, similar to those of the Thames, Wash, and Humber, there can be no doubt, from reasons that will appear later. And, as the rivers that formed this estuary resemble in their source and general course the others of the east of England, it does not at first appear easy to see why, in this case alone, the estuary should have entirely silted up, or why, in so doing, it should have given rise to a type of scenery that is quite unique. In searching for an explanation, one naturally tries to obtain a first clue from the Broads themselves, by asking what is known of their origin. Etymology is at once ready with the answer that the name is derived from the Saxon *Braedan*, "to broaden," signifying that they are simply the broadenings of rivers, much as Windermere has gained its title of "the winding river lake." But a very brief visit to the area is sufficient to demonstrate the error of this view of the case. Having heard of the fame of Broad sunsets, the writer, on the evening of his arrival

in the district, started to row down the Bure, hoping to reach Wroxham Broad in time to enjoy, in the quiet of its reeds and rushes, a sunset of which the clouded glory was worthy of Constable's country. The Broad was less than a mile distant by land, but for far more than that length the river kept at its uniform canal-like width, without any sign of its intention of broadening out to satisfy the definition: it was obvious that something was wrong, and the quest was abandoned. Next day, from the deck of a wherry, the matter was explained. Instead of the river passing through the Broads, it kept sullenly aloof from them; as we sailed down the river there was Broad to right of us, Broad to left of us, Broad in front of us, but by a series of ingenious twists and turns it managed to wind through the whole lot of them, either eluding any direct contact with them, or communicating only by a few narrow and often overgrown passages (*see* Fig. 2). With some exceptions it is the same elsewhere: the Broads are usually completely isolated from the rivers, which may flow round three sides of them, as, *e.g.*, at Surlingham (Fig. 1).

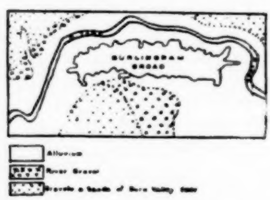


FIG. 1.—Surlingham Broad and its relations to the Yare. (1 inch to the mile.)

Etymology, in fact, was, in these cases, as misleading as usual, and was responsible for the very one explanation that was manifestly hopeless. The orthodox definition having thus collapsed, one was led to look around for some more reliable theory.

Lakes are usually classified[1] into six groups: (1) those occurring in rock basins, eroded by glaciers or formed by other agencies; (2) those due to the elevation of parts of the sea floor; (3) those lying along the depressions formed by the folding of rocks; (4) those due to the damming up of a valley by moraines or landslips; (5) those in extinct volcanic craters; and (6) those occupying mere hollows in clay. The Norfolk Broads are but slightly above, or are even below, the level of the sea, and are not separated from it by any rock rim, so they do not belong to either of the first two classes[2]: the valleys in which they lie are due to erosion through fairly horizontal strata, so

[1] *See, e.g.*, H. G. Seeley. Phillips' "Manual of Geology," ed. 2, 1885, pp. 134–7.

[2] A glacial origin has, however, been applied to the Broads (J. E. Taylor, the Norfolk Broads and Meres, Geologically Considered. *Trans. Norf. and Norwich Nat. Soc.*, vol. i., 1872, pp. 30–40), but the little evidence advanced in support of this conclusion is easily explained in other ways, and the direct evidence on the contrary is overwhelming.

that the rock foldings in the district will not help in the matter. The Broads do not bear any relation to the general glaciation, nor do they regularly shallow towards their lower ends in the manner characteristic of glacially eroded basins; there is not a trace of volcanic activity in the district, while the regular distribution of the Broads along the river valleys separate them from the irregularly scattered lakes of the last class, of which there are representatives in the area. The Broads, taken as a whole, therefore, do not fall under any of these six categories.

Though it is one article in the true geological faith that wherever there is land there is material for geological study, I had entered the district expecting to find much of interest in its flora and fauna but little in its geology; as far as previous experience went, flat tracts of alluvium, whether peat bogs as of Ireland or Sedgemoor, or deltas as of the Rhine, or river plains as of the Po, were, in spite of one's creed, of but little interest compared with the hills around them. Nor had a perusal of the literature of the area done anything to suggest that it would afford any very exciting problems; it is true that there had been a fierce and wordy war some 70 years ago, but the warmth of this was due to the fact that while one of the combatants was a geologist who scoffed at the historical "evidence" of his opponent, the other was an antiquarian who could not understand the scientific arguments of the former. In latter times an interesting lecture by Mr. H. B. Woodward, on "The Scenery of Norfolk," and the remarks in Mr. J. H. Blake's Survey Memoir, are the most valuable contributions, but in neither is the general question of the Broads discussed in any detail. It is to these authors, and to Mr. Clement Reid, that we owe the main part of our knowledge of the geology of the district.

The Broads themselves occur in a somewhat triangular area, with the coast line from Lowestoft to Horsey as the base and Norwich as the apex. A substratum of chalk occurs over the whole area, covered by the clays, &c., of the Lower Eocene along the eastern margin. Neither of these, however, are here seen at the surface, which is mainly occupied by gravels, glacial deposits, the alluvium of the old estuary, and the sand dunes that line the coast. Three rivers—the Bure, Yare, and Waveney—traverse the district. At first they flow through fairly steep valleys, which gradually widen out and unite into a broad level plain separated from the sea by a series of sand dunes or "meals," as they are locally called. Seen from the railway or the road the scenery is tame and uninteresting, the hills are low, the soil is heavy, and the valleys appear bare and flat. Viewed from the rivers or the Broads the whole aspect of the country changes; the hills, in contrast to the marsh that borders the waterways, now appear to stand out in bold relief, their slopes are well wooded, while clumps of fine oaks and elms mark out patches of gravel. The groves of lofty bulrushes that margin the

watercourses, the acres of flat-leaved pond weeds and water lilies that cover the Broads, and the dense tussocks of the sedge (*Carex paniculata*) that stand up like buoys to warn the sailor of the shoals, together form to the ordinary townsman a revelation of the charm and beauty of our water flora.

Reluctant though one may be to leave the water, it is necessary to do so if we desire a closer acquaintance with the geology of the district. Landing on the flat tract of meadow that borders the rivers, one gets an idea of its formation: the soil is everywhere damp and studgy, the surface is broken up by holes between the roots of the rushes or marsh plants, by the growth and decay of which these "rands" have been mainly formed. The hill-slopes, on the other hand, are composed of gravels and pebble beds, with occasional beds of fossiliferous ironstone, belonging to the Bure Valley beds, a series now of more than local interest since Professor Prestwich correlates it with the isolated patches of hill-gravel that stretch away to the south-west of England. Whatever may be the verdict upon this conclusion, there can be no doubt that the beds are here marine in origin, and that they were deposited in shallow water, probably in an estuary. Above these Bure Valley beds rests the series of sands, gravels, clays, and loams belonging to the Glacial Period: the chief of these is the Chalky Boulder Clay formed by the great ice-sheet that once covered East Anglia. The only bed later than these is the Alluvium, which forms the plains at the foot of the hill-slopes: but the glacial beds occur on the summits of the hills on either side of the valleys and rarely at lower levels within these; hence it is obvious that they once spread as a sheet over the whole district before the existence of the present valleys, only occasionally cutting down to lower levels. Now these valleys are of great depth; thus a boring at Yarmouth passed through 170 feet of drift[3] before it struck the London Clay, thus proving the existence there of a buried river channel 160 feet below the sea level, and therefore indicating a subsidence of the area to this extent. This might have been inferred, without any direct proof, from the fact that the valleys could not have been cut out by streams flowing with their present sluggish course. The whole fall of the Bure from Wroxham Bridge to Yarmouth is only about 2½ inches to the mile. An elevation of 160 feet would have turned the Bure into a torrent, with ample power for the erosion of its channel to this depth. As the excavation of the valleys commenced almost immediately after the close of the Glacial Period, it is quite probable that the elevation thus indicated was part of the great elevation which seems always to have accompanied, if not directly caused, the glaciation of temperate regions. The valleys were, however, certainly formed before the subsidence, so that when

[3] S. V. Wood has suggested that part of this may be really Crag (*Geol. Mag.*, iv., 1867, p. 560).

the land had reached its present level the area was occupied by a great estuary, the arms of which ran far up the courses of the three rivers. Probably before the subsidence had reached its maximum, the estuary had commenced to shoal, and in this case the silting was controlled by a factor which caused it to proceed on very different lines to those upon which the process has been carried out in other English estuaries. The nature of this factor we will now consider.

If one stands upon the sand dunes along the Norfolk coast as, *e.g.*, at Horsey, and looks out seawards, one notices lines of breakers parallel to the shore. These are due to shoals, and if we examine them, the coarsest material is found at their north-west end, indicating that the movement of the drift and beach material is here from north to south. The explanation of this movement must be sought in the peculiar circulation of the tide in the southern part of the North Sea: the main tide sweeps round the north of Scotland, and being concentrated by the contraction of the sea, it strikes with full force against the projecting coast of Norfolk, and drives along it to the south. When the northern tide begins to lose power, the southern tide that has been piled up in the English Channel forces its way into the North Sea, and as its passage through the Straits of Dover has given it a north-easterly set, it consequently follows the Continental coast. The circulation in the south part of the North Sea thus forms a great eddy, the tide sweeping south along the East Anglian coast, and returning along the opposite shores where the main projections, such as that of North Holland continued by Texel and other islands, point to the north. The fact that the tide practically always flows southward along this part of the English coast, has the effect of piling up the sediment on the north sides of the mouths of the rivers; and the gradual continuation of this action results in pushing them further and further to the south. Thus the Yare now opens at Gorleston, two miles to the south of Yarmouth, instead of its original mouth at Caistor, three miles to the north. Yarmouth itself was crossed during the passage, and the site of the present watering-place was a submerged shoal so late as 1000 A.D. Similarly the Alde, which opened at Aldeborough, on the north side of Orfordness, has cut a new course behind the London Clay hill at that point, and now opens to the south of it. The mouth of the Waveney was no doubt once at Lowestoft, but as this was barred, and as it was prevented travelling south by high land, it turned north and joined the Yare. The Hundred Stream is reported by tradition to have opened to the sea at Horsey, and such is by no means improbable; if so, its mouth was blocked, and it had to reverse its flow and become a mere tributary of the Bure.[4]

[4] Cases of the reversal of flow of rivers are rare, but well-authenticated ones are known. *See, e.g.*, the classical case of the Rhine, Sir A. C. Ramsey. *Quart. Journ. Geol. Soc.*, vol. xxx., 1874, p. 81.

The same southerly drift has affected other parts of the eastern coast: thus to it is due the great projection of Spurn Head; but in the case of the Humber, the river is sufficiently large to prevent its mouth from being seriously interfered with, and thus it has been but slightly deflected to the south. In the case of the Thames, the land to the north could not yield such masses of glacial boulders and other *débris* as the sea had to work with in Norfolk.

The influence of this barring of the rivers would be to at once check the velocity of the current at the mouth: the water striking the bar would immediately drop its load of *débris*, and thus strengthen the barrier by forming a shoal on the inner side. This would be built up further during floods, and by the growth of plants which would bind the loose sediment into a coherent mass, and by their decay gradually raise it above the water line. Thus, what would happen would be simply the silting up of the estuary at its mouth, instead of at its head as in the Wash, or along lines of still or "dead" water as in the Thames. This tract of silted land would, by the continuation of these operations, work its way gradually backward up the estuary, leaving a great sheet of water separated from the sea by a band of alluvium; of this Breydon Water may be the diminished representative. But as the land worked further backward, it would cross the entrance of branches of the estuary; the sediment would be carried along the central channel, upon the sides of which it would be deposited: it could thus cut off the branches either entirely, as in the case of Fritton Lake, or connected by a channel just sufficient for the escape of the surplus rainfall, as does the memorable Muck Fleet[5] for the three great sheets of Rollesby, Ormesby, and Filby Broads.

In such a way may be explained the origin of those Broads which lie in valleys off the main courses of the three rivers, but this will not suffice for those which lie along the rivers, and wholly surrounded by the alluvium. Let us take the most complex case. At the head of the alluvial plain of the Bure, at its junction with the narrow valley above Wroxham, there is a series of seven Broads, separated from one another and from the gravel hills on either side by tracts of ordinary "rand." The origin of the marginal rand is very simple: under the influence of the wind, rain, and frost, the pebbles constantly tend to roll down the hill sides into the Broad; upon the flat submerged bank thus formed, bulrushes and other plants would take root and help to raise it into a low terrace running at a uniform height along the foot of the hills.

The Bure must at this time have swept down the valley above Wroxham with considerable power, carrying with it much mud and sand. When the river struck the great Broad, which covered the

[5] "Fleet," it may be remarked, means ditch, and has no reference to the rate at which this Muck may be ascended.

site of the whole seven (*see* Fig. 2) its velocity and carrying power would be simultaneously reduced; it would, therefore, drop all its sediment as a delta or fan-shaped heap around its mouth. At times, when the river was low, this might tend to form a bar across its entrance, but during floods the river would unceremoniously re-cut its channel through this pile of *débris*, and spread the fan further outwards. As the fan grew, the whole face would not receive equal amounts of detritus; the middle would grow faster than the sides, and thus project into the Broads; rushes and plants growing on the shallow sides of the fan would help to complete the embankment, and confine the river to one narrow channel. Even during floods, when the river swept over the embankments, the stems of the dense rush grove would act as a sieve, and catch all the mud, and thus not only raise the main walls, but prevent the silting of the Broads on either side. All fresh supplies of sediment would, therefore, instead of being spread evenly over the floor, be piled up on either side of the mouth of the channel. In this way the embankment would in time

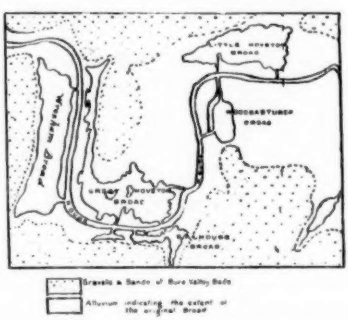



FIG. 2.—The Hoveton Group of Broads; occurring in a tract of alluvium (unshaded) the whole of which was once occupied by the original Broad. (1 inch to the mile.)

run right across the large original Broad, dividing it into two smaller ones, separated by the river and its embankments. The actual line of the embankments would be deflected by the influx of lateral streams, or follow the main current when it diverged from a straight line to avoid higher land. Tributaries, moreover, would in the same way cut up the two Broads into yet smaller ones, and the size of the whole would be gradually reduced by the slow inward growth of the rands around the margins.

Various local modifications occur owing to the different directions in which the rivers entered the Broads: thus at Ranworth the stream struck the middle of an elongated Broad, and has cut it into two nearly equal lobes. At Surlingham (Fig. 1) the Yare was deflected sharply to the north by the hill to the south of the Broad, which marks the site of a sheet of "dead" water left in this angle.

If this theory be the true one, then the Broads are gradually decreasing in size, as is well-known to be the case, and those which

still communicate with the rivers tend to become completely isolated. In fact, the size of the Broads may be some measure of their age: as the silting commenced at the seaward end, the largest Broads would be expected to occur at the upper parts of the valleys. Such, indeed, is the case; thus the great Hoveton and Wroxham Broads on the Bure, Barton Broad on the Ant, Hickling Broad on the Hundred Stream, Surlingham Broad on the Yare, and Filby and its associated Broads on the Muck Fleet, are all in the upper part of the valleys. A gradual decrease can be traced as the Broads are followed towards the sea, of course excluding those off the main courses of the rivers: they become smaller, more regular in outline, completely isolated, and further removed from the rivers. Thus on the great flat plain through which the Ant flows south from Barton there are two small isolated Broads, one a mile to the west of the river, and the other half a mile to the east. Along the lower courses of the rivers there are numerous such remaining to bear witness to the great sheets of waters of which they are the diminished representatives, much as the small oceanic atolls remain to attest the presence of the extensive fringing reefs from which they have arisen.

The peculiar type of scenery of the Broad area is thus the outcome of exceptional physical conditions; but we are tempted, in conclusion, to inquire whether there is any geological evidence as to the occurrence of similar conditions in the past. In considering this point it may be advisable to attempt to form some idea of the evidence that would be preserved in this area upon which a future geologist would have to rely in trying to picture its present physiography. To do this let us return to Horsey, and note how the north-easterly winds are driving the sand dunes over the adjoining country. A section here would expose a basement bed of clay containing estuarine and freshwater fossils, with occasional bands of marine shells, and also the roots of aquatic plants or of trees that love a damp soil. Above the clay would be a seam of vegetable matter formed of the stems of similar plants, with occasional clumps of tree stems: the whole of this seam would be remarkably free from mechanically derived sediment, thanks to the sieve of bulrush stems that grew around the margin; this bed would be in turn covered by a mass of sand or sandstone. But this is simply the description of a coal seam with its root-bearing underclay and its sandstone roof. Further, the occasional submergence of the coal-field, as indicated by the layers of estuarine or marine shells, the general flatness of the area (upon which Croll has laid such stress), and the purity of the coal secured by a marginal filter of plant stems, like the mangrove swamps of the Mississippi (to quote Lyell's comparison), are all points of striking resemblance between the Broads and the conditions under which our coal-fields were deposited.

Hence, though the Broads may not tempt the geologist with any large series of instructive diagrammatic sections, nor yield to

the collector a wealth of fossils or minerals, yet it is not without interest of its own; it enables us to follow in detail the history of the infilling of a great estuary, and it presents us with, perhaps, the closest analogy to the conditions of the formation of our coal-fields. The Norfolk Broads, therefore, are not so much of value as affording an opportunity for the study of one part of the geological record, as in the lessons they teach as to how some parts of that record were written.

## REFERENCES.

The following references may be some assistance to any who wish to follow the subject further. The most valuable contribution to the Robberds-Taylor controversy is the following: "On the Geology of East Norfolk; with Remarks upon the Hypothesis of Mr. J. W. Robberds respecting the Former Level of the German Ocean," by R. C. Taylor; published by J. Cochran, London, 1827 8vo. 68 pp., 14 pls (*See also Phil. Mag.*, vol. i., 1827, pp. 277–290, 346–353, and 426–432). The opposite side of the case will be found in the "Geological and Historical Observations on the Eastern Valleys of Norfolk," by J. W. Robberds, Jun. 8vo. Norwich, 1826. The controversy was continued in a "Reply to Mr. R. C. Taylor's Remarks on my Hypothesis on the Former Level of the German Ocean." *Phil. Mag.*, vol. ii., 1827, pp. 192–206 and pp. 271–285 To this R. C. Taylor replied in two papers: "On the Natural Embankments formed against the German Ocean on the Norfolk and Suffolk coast, and the silting up of some of its Estuaries." *Phil. Mag.*, vol. ii., 1827, pp. 295–304; and "On the Geological Features of the Eastern Coast of England, and Concluding Remarks on Mr. Robberds' Hypothesis." *Ibid.*, pp. 327–331.

A list of the most important Broads and their dimensions are given by R. B. Grantham in "A Description of the Broads of E Norfolk," of which an abstract was published in the *Quart. Journ. Geol. Soc.*, vol. xxv., pp. 258–9. Further topographical details and clear proofs of the estuarine nature of the Broad area are given in "The Geology of the Country near Yarmouth and Lowestoft," by J. H. Blake. *Mem. Geol. Surv.*, sh. 67, London, 1890, pp. 3–5, 74–9; in "The Geology of the Country around Norwich," by H. B. Woodward, *Mem. Geol. Surv.*, London, 1881, pp. 3–4, 143–4; in "The Scenery of Norfolk," by the same author, *Trans. Norfolk and Norwich Nat. Soc.*, vol. iii., p. 439; and again in his "Geology of England and Wales," ed. 2, 1887, pp. 594, 602–3. A general review of the glacial deposits of the area will be found in "The Glacial Drifts of Norfolk," also by H. B. Woodward, *Proc. Geol. Assoc.*, vol. ix., 1885, pp. 111–128. A summary of the literature on the Bure Valley beds will be found in Professor Prestwich's paper on the Westleton Beds *Quart. Journ. Geol. Soc.*, vol. xlvi., 1890, pp. 86–92.

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III.

# The Evolution of Flat-Fish.

IN the May number of NATURAL SCIENCE, Mr. J. T. Cunningham criticised a preliminary note of mine in the *Société de Biologie* (16 Jan., 1892), dealing with a curious monstrosity in a turbot found at Wimereux. In this note, which my critic appears to have imperfectly read, I have carefully distinguished those *monstrous* Pleuronectids which show arrested development (without stoppage in growth) from the double flat-fishes whose existence Cunningham says is recorded in almost every ichthyological work of any importance.

The former are sufficiently rare to have been recorded carefully by the authors. *Pleuronectes cyclops* of Donovan is probably the first example cited. Couch speaks of a similar case among the turbots (*Rhombus maximus*). MacIntosh and, more recently, Filhol have also met with examples, while the case noted by Yarrell relates to a Brill (*Rhombus lævis*). The same monstrosity, according to Couch, is not very rare among *Zeugopterus punctatus*, and we know that *Zeugopterus* differs but little from *Rhombus*. It has also been observed among the flounders, whose development is as slow as that of the turbot. Higgins records, under the name of *Pleuronectes melanogaster*, a flounder notched above the eyes, and of a very dark brown colour, almost black, on both sides. Newman, Thompson, and Ritzema Bos have noticed the same malformation in individuals of this species. These monstrous specimens differ from the normal not only by the colouring of the blind side, but also by the notch in the dorsal fin, by the much greater thickness of the muscles on this side, which changes the form of the vertical section of the fish, by the existence in the turbot of tubercles like those on the upper side, and by other anatomical characters to which I shall allude later, in a special paper.

I have stated that these monstrosities, by arrest of development, are more frequently to be found among *Rhombus* than among the other Pleuronectids. I ought rather to have said among *Rhombus* and the flounders, or in a more general way, as I have indeed indicated, among the Pleuronectidæ of gradual metamorphosis (palingenetic development). The accuracy of this assertion is not only verified by the authors quoted, but also by the fact that since I drew the attention of the

members of the *Société de Biologie* to this question four months ago, two large monstrous turbots have been noted to me, one at St. Vaast la Hougue, the other at Le Croisic, by colleagues who only occasionally visit the sea.

Double specimens constitute an anomaly entirely distinct from the preceding, much less profound, and much more frequent, since they are to be found among all kinds of flat-fishes. It is almost impossible to visit the fish markets in the French seaports without finding one or several specimens. Among the turbot, double specimens, or at least more or less spotted examples, must have been so abundant at a certain time, or in certain localities, that, as I have formerly remarked, our earlier ichthyologists (Daubenton, Bonnaterre, Lacépède) considered the piebald coloration of the under side as a specific character of *Rhombus maximus*.

Among the flounders at Wimereux the average of individuals completely double is about three per cent., but it would be much higher if we included in our statistics the individuals merely piebald. Malm has already recorded this frequency of specimens coloured on the under side, and he attributed it to the fact that, as the flounders lived near the mouth of rivers, in water continually agitated, their young were unable to hold themselves constantly on one side or the other.

After having definitely established the distinction between the two anomalies (1st, the arrest of development; 2nd, the colouring of the blind side), I found it insufficient to limit myself to the statement, as my friend Pouchet has done recently, *that it is very frequent to find several anomalies on the same specimen.*[1] Indeed, if it is ordinarily thus, it is because a first deviation in the development often entails in consequence other modifications. I have, therefore, tried logically to make the second anomaly subordinate to the first, and it is in consequence of this that I have been led to speak of observations well known and easily to be duplicated, at least in many cases, in the metamorphosis of the Pleuronectids.

I said that the turbot of which I speak "must have swum (*devait nager*) in a vertical position, and must have rested rarely on its right side." I am not in the habit of affirming what I have not seen for myself, and, what is more, I had the testimony of two such experienced ichthyologists as Day and MacIntosh in support of my opinion. Cunningham merely denies this evidence with the unnecessary remark: "this is simply an error of observation." Now, on what facts does Cunningham base this contradiction of his predecessors? On the observation of a double plaice (not monstrous), and even *imperfectly* double, since the posterior three-fourths of the lower side are coloured in the same way as the upper, the anterior fourth being

[1] G. Pouchet, Remarque sur deux turbots à face nadirale pigmentée. *Société de Biologie*, 5 mars 1892, p. 200.

white.[2] But these specimens are very numerous; all the fishermen know them, and it is needless repetition to tell us that they lie perfectly horizontally on the ground. In spite of this, Cunningham remarks: "Giard assumes that double fishes swim vertically." What I said was, that not the *double* but the *monstrous* specimen (which is very different) swims vertically; besides which, I do not affirm that monstrous flat-fishes swim all their life vertically, but only that they remain longer in that position than the others, and, in any case, long enough to allow the influence of the light to act efficaciously on the side ordinarily colourless.

Cunningham tells us that he has made a series of careful experiments to prove the direct action of the light on the skin of the under side of the flounder. Obviously, I can only speak of those experiments results of which he has published (*Zoologischer Anzeiger*, 1891), and the method adopted in these does not seem to be satisfactory, for as long as the young flounders were not covered by a net, the experiment was not conclusive, and when they were held down by a net (the meshes of which must have been extremely fine, since they prevented the renewal of the water), the fishes died rapidly. This experiment forcibly reminds one of that of the man in the fable, who, wishing to habituate his ass to eat nothing, saw the animal die of hunger at the very moment that his experiment seemed likely to succeed. Cunningham tells us to-day what he had neglected to mention in his previous paper, that "at Plymouth reversed flounders are exceedingly common, almost as abundant as normal specimens," and that he cannot see what disturbing influence this fact can have on his own experiments. "It is obvious," says he, "that if inheritance in the flounders acts as Giard supposes, there would be none but double flounders, since right-sided and left-sided individuals are always breeding with one another." This is an astonishing misconception of the laws which govern the products of cross-breeding among animals. As all biologists know, the progeny obtained by the union of two races cannot be intermediate between the two progenitors, but resemble closely one or the other. For instance, in a union between a female white mouse and a wild gray male, one obtains constantly young, and some of whom are completely gray others entirely white. Also, we know that a certain anatomical character has a better chance of reappearing in the descendants when it has disappeared more recently, and it is evident that a right-sided flounder which can count a certain number of left-sided individuals among its ancestors, will have a greater tendency to acquire the colouring on its left side under the influence of the causes which have determined in the race the possession of this colouring.

[2] The position of the eye and the terminating comb of the dorsal fin are not of much signification in the plaice, where the eye is normally almost on the edge of the head, and the dorsal fin terminates almost behind the eye.

I consider necessary the introduction of assumptions indicating to biologists in what sense they should direct their observations or their experiments, and which may suggest these experiments. I have long since expressed my opinion on those naturalists who have not sufficient imagination to create for themselves assumptions, or enough courage to give vent to them. We must run the risk of making mistakes sometimes, and be always ready to abandon a theory which is proved incorrect.

But before discussing with Mr. Cunningham the explanation that I have given of the asymmetry of the Pleuronectids, and which has been accepted by so competent a zoologist as Professor A. Agassiz, I shall wait till my contradictor has brought me conclusive experiments, or new observations, and not merely sterile and destructive criticism.

A. GIARD.

IV.

# Is Stigmaria a Root or a Rhizome?

IT is matter for congratulation that two such eminent authorities as Sir J. W. Dawson and Professor Williamson should have been moved simultaneously to a publication of their views on *Sigillaria* and *Stigmaria* (1). That this should have happened is of itself sufficient to show that the subject is an important one, and that its discussion at the present time is not inopportune. In again reverting to it, I do not propose to take up all the numerous questions it involves, and which, unfortunately, are not always clearly distinguished, but rather to deal briefly with one of them, viz., the question as to the morphological nature of *Stigmaria ficoides*, apart from its physiological functions. In doing so, no attempt will be made to formulate a final and decisive opinion, but simply to indicate the considerations that must be taken into account before the question can be regarded as settled. It may be that to many geologists and palæontologists a purely morphological question will possess but little interest, but to others, and especially to botanists, there will be no need to apologise for its discussion.

*External Characters.*—It has been pointed out again and again that the external characters of *Stigmaria ficoides* were considered by the older palæobotanists as inconsistent with the view that it is a root. So far as I know, no instance has yet been adduced in which a root bears rootlets arranged in a quincuncial order, and in which the rootlets become so regularly and so generally detached, leaving behind such well-defined scars as those met with in *Stigmaria ficoides.* Nor has any root hitherto been instanced in which the rootlets approach so closely to the growing point of the axis as they do in a specimen of *Stigmaria* described by Count Solms (2), where the appendages grow smaller and shorter towards the apex, the distances between them diminishing, while they become curved forward, and close up like a bud over the growing tip. The same authority points out that it is only as the appendages develop that they take up a position at right angles to the axis, so that they show the phenomena of epinasty and hyponasty like ordinary foliage leaves, phenomena which up to now have been unheard of in the case of rootlets.

In his communication to this Journal (3), Sir J. W. Dawson states that *Stigmariæ* " grew in the underclays or fossil soils, and that

their rootlets radiated in these soils in all directions." This may be accepted as a correct description of the state of affairs, but, as such, shows how much the so-called rootlets differ from those commonly met with in recent plants. In these, their positive geotropism induces them to grow vertically or obliquely downwards, no matter in what position they arise on the parent axis. In the case of horizontal rhizomes which give off rootlets from all sides—that of the common *Iris* for example—even the rootlets which spring from the upper surface soon curve over and grow downwards, and do not radiate "in all directions" as do the appendages of *Stigmaria*.

Finally, *Stigmaria ficoides* has *two* modes of branching, viz., by dichotomy and by the formation of lateral appendages at short intervals and on all sides. This is so unusual a phenomenon in the the case of roots that it is doubtful whether another instance can be cited where it occurs.

On the whole, then, it appears that the external characters of *Stigmaria ficoides* differ in several very important particulars from anything we are acquainted with in existing roots, and these differences do not seem to have been satisfactorily explained by those who advocate the view that it is a root. On the other hand, they are all in harmony with the hypothesis that it is a rhizome, and, indeed, so far as they go, give unqualified support to it.

*Internal Anatomy.*—Though not as completely known as could be wished, the internal anatomy of *Stigmaria ficoides* has been fairly well worked out by several investigators, especially by Williamson in his Monograph, published by the Palæontographical Society (4). As there described it possesses a parenchymatous pith, which at an early period becomes fistular, and this is surrounded by a zone of wood, made up of wedge-shaped masses of scalariform tissue, which are separated by medullary rays and were somewhat truncate at the apex. In the youngest axes, according to Williamson, the pith is surrounded by "a thin ring of very small vascular bundles," and the secondary increase in thickness is said to have been effected by means of a "meristem ring equivalent to a cambium zone" (5). It is important to observe, however, that the secondary increase proceeds outwards from the primary bundles, so that although the latter form the apices of the wood wedges, there is no line of demarcation between the primary and the secondary elements. Outside the zone of wood there are traces of a bast layer, which, however, is seldom preserved, and outside this again a cortex consisting of an inner and an outer portion, the former of which usually disappears with the bast to which it is contiguous.

Now, in this and other accounts given of the anatomy of the axes of *Stigmaria ficoides*, nothing is more striking to a botanist than the total absence of all those structural details which are everywhere recognised as morphologically characteristic of roots. There is no central cylinder with its pericycle and endodermis. There are no

centripetally-developed strands of xylem, nor any alternating strands of phloem. There is secondary growth in thickness, but it does not originate in the manner which is so characteristic of roots, but rather, so far as can be seen, in the way which prevails in stems. Hence it follows that anatomically there is scarcely a single character in the axes of *Stigmaria ficoides*, as found in this country, which, to a morphologist, is suggestive of a root.

*Anatomy of the Appendages.*—Some of those who have most confidently maintained the view that *Stigmaria ficoides* is a root, have naturally attached much importance to the anatomy of the appendages. I say naturally, because it cannot be denied that in some respects that anatomy bears some resemblance to what we find in some rootlets. Williamson has especially drawn attention (6) repeatedly to the fact that the single vascular bundle of the appendages has a likeness to the monarch bundles found in *Ophioglossum*, *Lycopodium*, *Selaginella*, and *Isoëtes*. Now, if it could be shown that this bundle is really homologous with a true monarch bundle, it would be a strong point in favour of the root hypothesis, *so far as it affects the appendages.* But there are difficulties in the way of doing this. In fact it *may* be a collateral bundle, and this seems to be the opinion of Count Solms (7). Secondly, its mode of origin differs widely from that of existing monarch bundles, which, according to Van Tieghem, arise in one of three ways (8). In most species of *Lycopodium*, by repeated dichotomy of the root trunk, the central vascular cylinder becomes reduced to the diarch type. At the next dichotomy each branch carries off half the xylem and half of each of the phloem strands, and these latter uniting, an arc of phloem is formed on one side of the xylem, and the monarch bundle is constituted. In *Lycopodium inundatum*, *L. selago*, some species of *Ophioglossum* and *Isoëtes*, the monarch bundle appears to arise from *a diarch bundle* by suppression of the phloem on one side of the xylem, while in *Selaginella* it sometimes arises by the suppression of one of the two xylem strands and the union of the two strands of phloem. Similar views, it may be added, appear to be held by Russow (9). Thus, however abnormal these roots may be in some respects, *they are perfectly normal in the penultimate stage, presenting the diarch structure* so common in Ferns, Equisetum, and other vascular Cryptogams. Now in *Stigmaria ficoides* the so-called monarch bundle of the appendages does not arise in any of these ways, nor does it originate from a diarch bundle. As described by Williamson (10), each bundle arises at the inner apex of a vascular wedge of the axis, and is presumably a derivative of one of the primary vascular bundles. In some cases, if not in all, the bundles share in the secondary increase of the axial bundles from which they arise, a peculiarity by no means of common occurrence. Apart from this peculiarity, the mode of origin of these bundles approaches much more closely to that met with in the bundles of leaves than to that found in rootlets which arise from a root. From

all this it seems reasonable to conclude that if not altogether nullified, the evidence afforded by these bundles in favour of the view that the appendages are rootlets is considerably weakened. Still, for the present, it may be well not to insist upon this and to leave the morphological nature of the appendages, so far as it is to be interpreted by structure, an open question. It hardly needs to be said that even if they should eventually turn out to be rootlets, that of itself would not be decisive of the nature of the axis.

Summarising what has been advanced, it may be said then that so far as external characters and internal anatomy are indications of the morphological nature of the members of a plant, the facts seem to point to the hypothesis that *Stigmaria ficoides* is a rhizome as the true one. No one at this day disputes the fact referred to by Sir J. W. Dawson and Professor Williamson, that *Sigillariæ* and other Carboniferous plants were continued at the base of the stem into *Stigmariæ*. But this throws no light on the morphological nature of the latter, although it may be conclusive enough as regards their physiological functions. As the matter presents itself to a botanist, it is for those who maintain the root hypothesis to explain how it happens that all the characteristic root structures are absent, while so many that are characteristic of stems are present. It may be urged that, in Carboniferous times, the laws of plant morphology were different from what they are to-day, and that we cannot interpret palæophytic structures in terms that are applicable to existing plants. To this it may be replied that a generalisation so far-reaching as this ought to be established on independent and indisputable evidence before it is applied deductively to the solution of a controverted question. As a matter of fact, palæobotanists do not act upon any such principle in dealing with the great majority of Carboniferous plants, but, on the contrary, continually base their inferences as to structure, affinities, modes of development, &c., on the assumption that the same general laws are applicable to the whole Vegetable Kingdom and to fossil as well as to recent forms. Another contention that may be advanced is that the various members of plants were not so sharply differentiated in Carboniferous times as they are to-day. This, at first sight, is a plausible contention, and deserves candid and impartial consideration. But care must be taken to avoid confusion in this matter between the plants of an earlier geological epoch and plants of a less complex organisation. Among recent plants, the distinction of root and shoot is well-known to be absent from the lower forms, and to be restricted to vascular Cryptogams and Spermaphytes. Hence there is no impropriety in saying that in the lower forms the members of the plant body are not so sharply differentiated as in higher types. But to apply this generally and without qualification to Carboniferous plants is a much more questionable proceeding. Much, indeed, if not everything, depends upon the type of plants that are under consideration. So far as I am aware,

no palæobotanist maintains that in the Ferns and Coniferæ of the Coal-measures we ought not to expect the usual morphological distinctions between the roots and the stems, and until positive proof is adduced to the contrary, it may be fairly assumed that in the fossil Lycopodiaceæ such distinctions are not altogether obliterated. If this reasoning be sound, then, whatever truth it may have elsewhere, the contention under discussion can scarcely be applied to explain the absence of all the characteristic root structures from the axis of *Stigmaria ficoides*.

It may be submitted, then, that the plant morphologist is within his rights in appealing to the structure of *Stigmaria ficoides* for assistance in the determination of its morphological nature, and in endeavouring to interpret that structure in accordance with the general laws of plant anatomy. When this is done, it appears, as I have endeavoured to show, that its organisation approaches closely to that of a stem, and has nothing in common with that of a root. Moreover, as we know from observation that it was not aërial, the conclusion is indicated that it is a rhizome. As was intimated at the outset, however, the formal and definitive assertion of this conclusion as an established truth is beyond my present purpose. Hitherto, the upholders of the root hypothesis have not dealt in detail with the facts to which attention has been called, and it remains to be seen, therefore, how far they can reconcile the one with the other.

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THOMAS HICK.

II.

## A REPLY TO MR. HICK.

I fully agree with Mr. Hick when he intimates that morphological considerations have an equal, or even a greater value, than physiological, when endeavouring to ascertain the true nature of *Stigmaria ficoides*. But while admitting this, I am not prepared to follow him in appealing too strongly to conditions now found among living plants, and pushing them too far when endeavouring to explain the very different combinations that so abundantly present themselves among the Palæozoic forms. At that period no Angiosperms existed on the earth, and even the Gymnosperms were very far from reaching their modern development. Under these circumstances, the Cryptogams chiefly became the giant forest-trees of that remote age. To become such, they required an organisation very different in some respects from that of their degraded living representatives. Hence, we must not appeal to these degenerate types for illustrations and explanations of structures no longer existing. Still less must we turn to what we find in the Angiosperms, that wholly distinct race which has taken the place of the primæval Cryptogams in our woods.

The primæval giants of the swampy forests had doubtless a morphology assigned to them adapted to the physical conditions by which they were surrounded, but if even their dwarfed and otherwise modified descendants fail to throw light upon morphological details once so common, still less must we expect to obtain that light from the living and wholly different flowering plants. In this respect the *via media* is the safest. That these modern forms are in some line or other descended from the primæval types is accepted by every Darwinian. Hence, while we accept from the former any light that they can throw upon peculiarities in the latter, we must not deny that those peculiarities were real because they are no longer to be found among living plants.

The question before us seems, at the first glance, to be a very simple one, but it is less so than it really appears to be. Are our British forms of *Stigmaria roots* or *rhizomes?* We are soon involved in difficulties unless we disputants are agreed upon the sense in which we employ these two terms. To be certain on this point, I have selected the definitions of a rhizome given by Sachs, by Maout and Decaisne, and by Henfrey.

Sachs says: "It is of very common occurrence with Cryptogams and Angiosperms for a persistent primary axis or branch-system to continue to grow underground, and to send up only at intervals long

foliage-leaves or shoots, which subsequently disappear in their turn, and are replaced by others. When such axes or branch-systems lie horizontally or obliquely in the ground, *and produce lateral roots*, they are called rhizomes."—*Text-book of Botany*. 2nd Edition. English translation, p. 216.

Le Maout and Decaisne say: "The rhizome or root-stock is a stem which extends obliquely or horizontally below or on the surface of the ground, the advancing portion emitting fibrous roots, leaves, and shoots, the posterior gradually dying."—*Descriptive and Analytical Botany*. Hooker's translation, p. 11.

Henfrey says: "The *leaf-scaled stem*, found especially among herbaceous perennial plants, is seldom continuous with an axial root. On the other hand, it is very prone to produce adventitious roots, as is natural to its usually subterraneous or creeping mode of growth." "If the main axis persists, producing a few branches each year, and dying away behind but slowly, as it advances forwards, a more or less root-like structure is produced, termed a root-stock or rhizome."—*Elementary Course of Botany*, p. 25.

We have here three definitions from works and authors of the highest authority—one German, two Frenchmen, and one Englishman. I ask my opponents on what one point does our British *Stigmaria* correspond to any of these three?

Let us examine Mr. Hick's arguments on this matter.

*External Character.*—Even if no root is now to be found on the earth on which the rootlets are arranged in quincuncial order, it does not follow that such an arrangement could not formerly have occurred. We have now no aërial Reptiles with wings twenty feet across, nor archaic birds with their mouths full of true teeth; but no one dreams of advancing this as an argument against the former existence of the Pterodactyle and the *Hesperornis*. I will therefore dismiss this argument as valueless.

Mr. Hick's next two arguments seem to me to neutralise one another. In the first, the supposed rootlets cannot be rootlets because in a specimen seen by Graf Solms, as these rootlets approached the tip of the root, they bent towards its top, thus approximating towards the condition of the leaves of a bud. In the second he seizes upon Sir William Dawson's statement that the rootlets radiate in all directions, hence they differ from those "*commonly* met with in recent plants." What is or is not commonly met with cannot be of much importance to an argument relating to the *Stigmarian* question. I again leave these two opposite objections to neutralise one another.

Mr. Hick tells us that *Stigmaria* has two modes of branching, one by dichotomy, and the other by the development of the lateral appendages or rootlets in quincuncial order. I object to these latter organs being designated branches. Morphologically, it is not impossible that they may rather be regarded as highly developed and

symmetrical emergences; *functionally* they obviously performed the work of root-hairs; anyhow, they were not branches in the ordinary acceptation of the word, and in the sense in which the dichotomy of the large roots is a true ramification.

The external characters of *Stigmaria* "are all in harmony with the hypothesis that it is a rhizome, and, indeed, so far as they go, give unqualified support to it." I must confess that this statement of my old friend almost takes my breath away. It is difficult in a short controversial communication like this to go into the details of the subject, but I say unhesitatingly that, in my mind, and I think I know as well as most people what the detailed features of *Stigmaria* are, that no dogmatic statement could be further from the truth. I ask my readers to go over the three definitions of a rhizome quoted at the beginning of this communication. First and foremost we have always root, leaves, and, at intervals, growing buds, one of the latter especially being present at the apex of the rhizome, and that one usually being the largest and the strongest, while the retral end of the rhizome is usually either already dead and decayed, or in process of becoming so. Now I ask anyone who is unable to visit the museum of Owens College and thus see the magnificent specimen preserved there, to consult my Monograph in the publications of the Palæontographical Society. Though a poor substitute for the grandeur of the original as it is now preserved, let him refer to the photograph on plate xv., or to the diagram drawn to scale on page 46, and tell me where to find any one of the features of a rhizome. Instead of the retral death and decay of such structures, we have the four primary uncompressed roots, ancient as the central stem itself, and having a mean diameter of 32 inches, but the various divisions of which ultimately tapered to a very small diameter. On page 49 of the same Monograph the reader will learn how I traced on the spot one root of a similar but yet larger tree, along its subdivided and tapering length for 37 feet 4 inches, reduced at its apex to a mere point. What is there here corresponding to the swollen bud which occupies the distal lengthening extremity of a true rhizome? I further ask, Where are the lateral branches, each terminating also in a growing bud, seen in every rhizome?

In addition to this, what have we in the shape of appendages corresponding to the admixture of leafy growths forcing their way upwards, and of the roots bending geotropically downwards, to bury themselves in the soil? Not one of these features, characteristic of a rhizome, exists, and yet we are asked to believe that not only are these structures "all in harmony with the hypothesis that it is a rhizome, and, indeed, so far as they go, give unqualified support to it." Well might such a statement take my breath away! But I have not yet done with it. The question still to be considered, seeing that every other kind of appendage is absolutely absent from the Stigmarian root except what I affirm to be rootlets, is, What are the

facts relating to this part of the subject? Seeing, then, that *Stigmaria ficoides* is absolutely devoid of any and every kind of appendage excepting these organs, can anything but rootlets be made of them? Each one has the characteristic structure described in my Monograph. They scarcely present the variations that might be expected in a large number of individuals of the same organ. I have certainly studied hundreds of thousands of these objects, and I fearlessly affirm that, apart from the changes due to growth through long periods of time, the organisation of one is that of them all. Now, such being the case, are we to call these objects root-appendages or leaves, because they cannot be both? To begin with, their symmetrical quincuncial arrangement forbids this. If, then, such cannot be, if we determine to call them leaves, where are the roots of the rhizome? and, if they are rootlets, where are the leaves?

M. Renault boldly took the bull by the horns, and declared that some of them were the one and some the other; but this is sheer nonsense. Assuming, then, as I do, that they are rootlets, what is to be said for that argument? Mr. Hick refers to M. Van Tieghem on the subject; now it was from M. Van Tieghem's paper on Symmetry in Plants chiefly, I first learnt what is fundamental of my knowledge on the subject of monarch, diarch, and other similar modifications of this symmetry as it presents itself in roots and rootlets. At an early period of my work I satisfied myself that the rootlets of *Stigmaria* were examples of the monarch type of root. I at once sent him specimens of these Stigmarian rootlets. He was not long in replying "They are the monarch roots of a *Lycopodiaceous* plant;" a decisive reply of our highest authority on the subject. Mr. Hick thinks he has settled the question by expressing the suspicion that these rootlets may be collateral. It may strengthen his conviction when I tell him that they are collateral, so far as the bundle consists of a xylem and a phloem element arranged side by side, as he will see when he consults fig. 52 of my Monograph, but their development from a monarch tracheid, side by side with a phloem element, was followed by a subsequent series of processes that has no parallel in the living Lycopodiaceæ. The reason for this is obvious: the living forms have no true exogenous development of a vascular zone. No one worth naming now opposes the truth promulgated by me nearly twenty years ago. In most of, if not all, the Carboniferous Lycopodiaceæ, such a growth was developed on an extensive scale. The tree, originally an embryo produced from a minute macrospore, often lived to be more than a hundred feet in height, and its stem attained to more than three or four feet in diameter. Whatever may be the function of the vascular tissues of its rootlets in connection with the absorption of nutriment from the soil, they must have some function to perform. In a small seedling this work required but little machinery for its performance, but when the embryo became an arborescent structure even the rootlets were supplied with additional vessels, to enable

each one to take an increased share in the work. Little by little, as each new exogenous vascular zone was added to the entire exterior of the secondary wood, *which wood alone extended into the subterranean structures*, the upper margin of each pre-existing rootlet bundle received an additional vessel or two, developed in a continuous line from the periphery of the xylem zone, through the cortex, and terminated on the rootlet bundle, between the pre-existing tracheids and the phloem in contact with them. This continuous growth in size, and in the number of the tracheids constituting this rootlet bundle, is another of the many features of common occurrence among these Carboniferous plants which are never met with in any recent form. But these processes in no way make the rootlet bundle other than a monarch; and Mr. Hick himself admits that "If it could be shown that this bundle is really homologous with a true monarch bundle, it would be a strong point in favour of the root hypothesis." In this I agree with him. The root-bundles of the ancient and the modern types are as homologous as the stem structures of the two, *i.e.*, so far as homologues can exist between plants which, though belonging to the same great family, are, nevertheless, in some respects so differently organised.

I have dealt thus far with Mr. Hick's arguments because they are but the superficial echoes of the ideas of M. Renault, the high priest of the doctrines which I reject; who, in calling *Stigmaria* a rhizome, has constantly in view the angiospermous structures so named, with which it has no kind of relationship. M. Renault declares that *Stigmaria*, like the mint or the water-lily, develops leaves and shoot-producing buds, as well as rootlets. I deny as emphatically as ever that our British *Stigmariæ* do anything like this; hence it neither is, nor can be, a rhizome in the sense in which these writers use that term. But I have long had in mind another much more complex aspect which these *Stigmariæ* present, and which has not yet received the attention that it demands. The combined peculiarities presented by this remarkable organism seem to me to demand a special and different nomenclature. In my next communication on the subject I hope to present these hitherto undiscussed aspects in a definite form, whatever may be their true value.

W. C. WILLIAMSON.

III.

## A REJOINDER.

There are only two or three points in Professor Williamson's reply which seem to call for immediate comment, and this, of necessity, must be extremely limited.

(1.) The specimen in the Manchester Museum at Owens College does not seem to me inconsistent with the statement that "the external characters of *Stigmaria* are all in harmony with the hypothesis that it is a rhizome." Much depends upon the interpretation put upon its various features, and it is here that the divergence of opinion really begins. To show, however, that I am not alone in my estimate of the significance of these characters, a further reference may be made to Count Solms' "Fossil Botany" (p. 288), where substantially the same view is put forward.

(2.) My references to Van Tieghem are to his latest views on the origin of the vascular bundles which plant anatomists regard as being *truly monarch. Apart from the mode of origin*, these bundles are scarcely, if at all, distinguishable from collateral bundles. I do not gather, from Professor Williamson's statement, whether Van Tieghem was acquainted with the development of the bundles of the appendages of *Stigmaria* when he pronounced them to be monarch. But it may be mentioned that Count Solms, who is familiar both with their structure and development, writes of them as follows ("Fossil Botany," p. 277):—

> "That the bundles in this, as in the preceding case, are *collateral* and capable of secondary growth, is evident at once from the inspection of a transverse section figured by Williamson." (Monograph of *Stigmaria ficoides*, pl. xi., fig. 61.) [Italics mine.]

(3.) As the authority for the more important statements made in my article is given in every case, it seems both unnecessary and undesirable to introduce the name of M. Renault, who is not referred to in any way, and who is certainly not to be made responsible for what I have written. Not less desirable is it to avoid mixing up the question of the morphological nature of *Stigmaria* with a discussion of the systematic position and affinities of the plants to which it belonged.

THOMAS HICK.

V.

# Agricultural Museums.

THE good old days, when it was thought sufficient if a man were able to do his work in a rough and unintelligent way, are passing by. The mere acquaintance with routine and practical details, which served the fathers, will no longer do for the children, and the head must be brought into play as well as the hands. The apprenticeship, which used to be everything, is only a part of the training for the various branches of industry. The advance of Science, and the wider application of scientific methods, together with foreign competition, are responsible for much of this. Be the cause what it may, we are entering on a new era; and the change is little short of a revolution. Mechanics' and technical institutes are being opened in all the large centres, where the youth of the place may go in the evening and, under skilled instructors, learn something about the tools they work with and the forces they use. And the movement has excited considerable interest, and is likely to be increasingly taken advantage of.

This is in the right direction, competition or no competition. It will not only produce better results, but also give the workman more pleasure in his work. Probably the time is not far distant when it will be insisted upon as a necessary part of a man's training, and when the apprentice will be released for part of the day in order that he may acquire it. This will come about in quite a natural way when it is found out that the man who knows what he is about has an advantage over the rest. Such institutions are only possible where the population is concentrated, and in such places they will doubtless soon be put on the safe basis of permanent endowment or assured annual income from some public source.

The County Councils have taken up the idea, and are applying it as far as it can be carried out in outlying districts. These bodies are wisely seeking to bring within reach of the ploughman, and even of the farmer himself, a more intimate and scientific acquaintance with field and farmyard. Perhaps nothing has advanced more rapidly in recent years than the Science of Agriculture, or rather the application of the sciences to agriculture. We are already in the habit of talking of the farmer of the old school as a being very much behind the times. The treatment of the soil and the raising of

the stock are capable of being conducted in a much more efficient way, if but the requisite knowledge be there. The question is, how to provide this for the dwellers in our thinly scattered farms and cottages. The present system of itinerant lecturers visiting in succession the country villages, and gathering an audience from the surrounding district into some school-room or other available place, is on its trial. In a few places it has succeeded in attracting and even interesting those it was meant for. In the majority of instances, perhaps, it has failed, often miserably failed, to rouse the bucolic mind from its lethargy, or draw it aside from its usual method of spending its evenings. It may be that country people are not quite awake to what this invasion of their solitude means, and have not yet come to any conclusion as to what sort of creature this new kind of packman is. Some seem to be more amused than edified, and are accused of the levity of a passing joke at the man of science. The scheme is certainly open to the objection that they are scarcely prepared for it, especially when the lecturer insists on airing his superior information; and also to the suspicion in the most successful cases of leaving little permanent influence behind. Those who have tried have sadly to confess how little they can teach to any purpose even in a session of continuous work, and are disposed to be sceptical of the fruit of ten or twelve lectures hastily cast on such rough soil.

It is easier, however, to criticise than to suggest anything which will serve the purpose better. The want is a difficult one to meet and itinerancy seems the only solution in the meantime. When our educational machinery is completed, perhaps technical as well as secondary instruction will be provided in country schools.

As an auxiliary to this or any other scheme, would it not be possible to have a museum in which the facts could be presented to the eye? In addition to illustrating the lecture, it would remain a permanent element when the lecturer had departed. There are few country districts where a room might not be had which could be opened every evening, after six or seven o'clock, for those who cared to visit it and spend an hour there. Not a general museum, which is only a sort of show place—general things seldom do very much good, but a strictly agricultural museum, containing only what is interesting and valuable to country people, arranged in an easily intelligible way. The rent of such a place would be trifling, and the trouble of getting the things together and grouping them would not be great.

This paper is intended to show not how such a museum might be laid out, but how it is actually being laid out in the neighbourhood of Dundee. At least a start has been made, whatever the end may be.

Plainly, the thing to begin with is the soil. That is the basis of the whole matter. To the ordinary farmer, much more to the ordinary ploughman, soils are soils. They need ploughing, manuring,

and reaping at the proper seasons, and that is all. But, possibly, a little more intimate acquaintance with them would be found to repay the trouble. Now this museum of ours brings clearly out the fundamental fact that soils are the outcome of the disintegration of rocks, and it does this in the simplest manner possible, *i.e.*, by showing every stage in the process from the rock to the resultant soil. The parent rocks may be distant, as in the case of alluvial soils, or the glacial subsoils with which the lowlands of this district are so largely covered, but, near or distant, the relationship exists. The scheme reaches even further back than the rock. Some rocks are of comparatively simple structure—for instance, Sandstone; others are comparatively complex, as Gneiss, and Granite. In the first row of boxes are placed the minerals which enter into the composition of the common rocks, as rock crystal, calcite, felspar, hornblende, mica, augite, olivine. In the second row follow a few of the typical rocks, built up out of one or more of these minerals, those common to the district, as Old Red Sandstone, quartz, limestone, gneiss, granite, dolerite, being preferred. A few of these typical rocks have been selected to illustrate the process of decomposition. In succeeding rows of boxes the gradual formation of the more familiar soils is illustrated, and it is shown whether this happens with or without chemical change. Sandstone, dolerite, and granite already occupy the fourth, fifth, and sixth rows, and the other rocks of the county remain to be added.

The composition of the minerals which make up the rocks is clearly stated both in words and in chemical symbols, and every stage in the progress of decay is made plain in the same way. It. thus appears that soils are largely made up of alumina and silica According to the preponderance of one or other of these, the soil is known as sandy or clayey. When neither is in excess the result is a loam. In addition, there are often minute varying proportions of iron, lime, manganese, sodium, potassium, sulphur, and in some cases phosphorus. In the last of these boxes, illustrating the process of decomposition, the surface layer, the soil proper—darkened by the decay of animal and vegetable organisms (humus)—is placed. A rough outline of one of these cases which will show the arrangement followed is given on the next page:—

| Minerals. | | Typical Rocks. | Decomposition and formation of soils. | | |
|---|---|---|---|---|---|
| Rock Crystal—oxide of silicon, $SiO_2$. | Augite, &c. | Old Red Sandstone, $SiO_2$. | Dolerite—original rock. | Granite, &c. | Sandstone, &c. |
| Calcite—carbonate of lime, $CaCo_3$ | Olivine, &c. | Limestone, $CaCo_3$. | Passing into diabase. Lime in felspar and augite has united with $Co_2$ to form $CaCo_3$,&c. | &c. | &c. |
| Orthoclase—potash, felspar, silicate of alumina and potash, $Al_2O_3, 3\,SiO_2, + K_2O, 3\,SiO_2$. | &c. | Mica schist, mica, and quartz. | More advanced stage, augite almost completely decomposed. | &c. | &c. |
| Mica—silicate of alumina, potash, and peroxide of iron, $3\,Al_2O_3, SiO_2, + K_2O, 3\,SiO_2$. | &c | Gneiss, mica, felspar, quartz. —— Granite, mica, felspar, quartz. | Yellowish brown grit or earth formed by chemical decomposition. | &c. | &c. |
| Hornblende, &c. | &c. | Dolerite, felspar, augite, olivine, &c. | Soil from near the surface, darkened by decayed vegetable matter. | &c. | &c. |

In a second case an attempt will be made to bring out in as clear a way as possible the relation of the soil to the plant and animal life of the farm. Obviously organisms live and grow because they get out of the earth and air something which nourishes them. The most satisfactory way perhaps of finding out what that something is is by analysis.

Some such arrangement as the following will be adopted as a kind of educational experiment. The first row of boxes will contain the inorganic elements, metals, and non-metals found in the soils and also in the substance of plants and animals, such, for instance, as the calcium and potassium of felspar, the iron of augite and olivine, and the phosphorus of wheat and animal tissues. These will be arranged according to their greater or less abundance. The soils will follow in the next row, the order indicating the variety of their constituents and their consequent fertilising power. Heading the others will be placed an alluvial soil, which, having been brought from a distance, is probably the waste of many different kinds of rocks, whose ingredients have been finely sifted and mingled by water. Then the dolerite, which, when thoroughly decomposed and allowed to accumulate, is sufficiently complex, and therefore fertile, down to the comparatively homogeneous chalk or barren sand.

In a third row of boxes the soils will be arranged with a view of showing what they are specially rich or deficient in. Then will follow the analyses of the different crops raised, and over against each will be placed the special manure, or manures, needed to mee their special wants. The scheme is rudely indicated in the accompanying plan :—

| Inorganic Substances, Metal and Non-Metal, in Plants and Animals. | Soils. | | | |
|---|---|---|---|---|
| | Comparative fertility. | Composition. | Analyses of | |
| Sodium Na | Alluvial, very fertile | Clay rich in potash ·76 phosphoric acid $H_3PO_4$ ·16 | Wheat. | Special Manure |
| Phosphorus P | Volcanic, fertile | Sand silica 95% K 07 $H_3PO_4$ ·10 Lime 1·8 | Oats | Do. |
| Potassium K | &c. | &c. | Barley | Do. |
| Sulphur S | Calcareous, comparatively poor | Chalk, rich in lime 30% | Turnips | Do. |
| Calcium Ca Iron Fe., &c. | Sandy, barren | Peat, organic matter in excess | Clover | Do. |

It remains to make the acquaintance of the live stock. One can scarcely imagine any intelligent farmer or ploughman who does not wish to learn all he can about his chief property. The farm animals are not very difficult to understand; and it ought not to be an impossible task to represent the main features of their structure and relations to the eye. The facts that the hoof is an enlarged nail-covering over the first joint of the finger or toe, and that the so-called "knee" is really the ankle or wrist, and the lower part of the leg beneath "the knee" represents the bone or bones in the substance of the hand or foot metacarpal or metatarsal, and that the animal therefore walks on the tip of the finger or toe, ought all to be clearly expressed. The common ancestor of all the ungulates, with its five toes or digits on each foot, and their gradual reduction to four in the Rhinoceros, ought also to be indicated.

The bearing of the character of the toes on classification should also be clearly shown, with examples of the odd-toed group, the perissodactyla, and the even-toed group, or artiodactyla. The other characters by which this is generally accompanied might also be illustrated.

For instance, in the odd-toed ungulates the stomach is simple, while in the even-toed it is more or less complex; in the former the dentition is usually complete, in the latter it is usually incomplete.

The museum will present all the peculiarities of these animals by a very simple process of grouping. The odd-toed horse will come first with its simple stomach and its four kinds of teeth. The even-toed sheep (ruminant) will be last with its highly complex stomach and very incomplete dentition ; and between them will be placed the omnivorous pig, with its very slightly-divided stomach and its almost complete dentition.

This is only the nucleus of a teaching museum, and manifestly a great many things remain to be added before any approach to completeness is made. A small case may profitably be used to make those interested better acquainted with the different grasses grown in the fields and their relative value for grazing purposes. In the present state of information it would be a risky experiment to ask the ordinary agriculturist to point out the perennial rye grass (*Lolium perenne*) and to indicate its exact position in the order. In this district there is no commoner grass in our hay-fields than Yorkshire fog (*Holcus lunatus*), which only ranks as a weed grass, and whose presence indicates poor land or bad tillage.

Another case may be made to indicate the natural use of food-stuffs with a view of producing certain definite results; and still another devoted to fruit culture as a subsidiary branch of farming, and one which is likely to rise in importance if small holdings become general. Even the arrangement suggested is by no means final. Details might be added or subtracted, and a fresh grouping followed as a better way suggested itself. It is not necessary that one should be a repetition of the other; indeed, it would be a weakness and a hindrance if it should be so. The local conditions of farming differ, and will suggest that greater prominence should be given to one thing in one district and to another elsewhere. All that is meant here is to point out the use such an institution might serve in the enlightenment of farmers and ploughmen, in the economy of material by the more accurate adaptation of means to ends, and in the consequent spread of scientific agriculture.

J. H. Crawford.

## VI.

# Amber and Fossil Plants.

OF the various media of fossilisation there are few, if any, which afford us such vivid glimpses of the period in which the organisms preserved as fossils formed part of the existing faunas and floras, as Amber and its included organic remains. To most people the fact of insects being found in Amber is well known, but few, possibly, are aware of the botanical treasures which have been found embedded and almost perfectly preserved in this substance. Plant fragments sealed up in fossil resin, with the minutest detail of structure intact, reveal many facts of no little interest from a botanical and geological point of view: they afford us, moreover, a faithful record of the conditions which obtained in those forests whose trees supplied the preserving material.

To briefly refer to a few of the plants and plant fragments found in Amber, and note what conclusions may be drawn from their examination, may not be without interest.

Our knowledge of the Amber plants is due mainly to the labours of Goeppert, Menge, and Berendt; and in more recent years Conwentz has contributed exceedingly interesting and valuable memoirs on the same subject.

The substance Amber, first mentioned by Homer, began to attract attention in 600 B.C., when Thales, of Miletus, one of the Seven Sages, discovered its remarkable properties from which sprang the Science of Electricity, so called from the Greek term for Amber, ἤλεκτρον. Without attempting to trace the history of Amber and of the various theories as to its true nature, we may note that, even in the time of Aristotle and Pliny, guesses were made as to its source of origin which came very near the truth. Under the general term *Amber* are included a number of fossil resins whose chemical and physical properties need not be considered in detail. The following varieties are mentioned by Conwentz (2):—*Gedanite*, *Glessite*, *Stantienit*, *Beckerite*, and *Succinite*. *Succinite*, the commonest and best known of these, is generally described as a resin exuded from an extinct species of Pine, *Pinus succinifera* (Goepp.). Doubtless this species of Conifer was only one of several which yielded this particular kind of resin. The chemical composition of Succinite is given by

Helm[1] as follows:—Carbon, 78·63 %; hydrogen, 10·48 %; oxygen, 10·47 %; and sulphur, 0·42 %. Its specific gravity is from 1·05 to 1·09, and hardness from 2 to 3; slightly brittle, and with marked conchoidal fracture.

From the days of Phœnician traders up to the present time, the Baltic coasts have supplied by far the largest quantities of Amber; the present annual yield in Prussia alone being estimated at a value of three million marks (6, p. 828).

The Baltic Amber occurs in a rolled condition in lower Oligocene strata. Credner, in his "Elemente der Geologie" (1, p. 700), quotes a typical section from Runge, giving the following succession, in descending order—(1) Surface soil, (2) "Diluvium," (3) Brown-coal, (4) Glauconitic Amber-bearing beds. The strata rich in Amber have an average thickness of 1·3 to 1·7 metres, and are for the most part below sea-level. Along with the rolled pieces of Amber in the glauconitic sand and clays occur various marine mollusca whose remains became embedded in the sediment, mixed with the hardened resins and vegetable *débris* carried down by rivers which flowed through the Pine Forests of Scandinavia and Finland. Washed out of the cliffs by marine denudation, the Amber is picked up at ebb tide or collected in nets, and by other means at high tide; in some localities it is obtained by mining.

From the abundant occurrence of this fossil resin in the drift of Jutland, Denmark, Sweden, Holland, and other districts, it is considered probable that the amberiferous strata formerly extended over a wide area in Northern Europe.

Although the Königsberg district is much the richest, other localities and other geological horizons have yielded Amber in greater or less abundance. From the Greensand of North America, from Miocene beds in Sicily, from Tertiary strata of France (Loire Department and Paris Clay), from Basle, Galicia, Roumania, Greenland, the shores of Spain, and other regions, Amber has been obtained in varying quantities.

In England this fossil resin has been found in the Cambridge Greensand, the London Clay in the neighbourhood of Kensington, on the shores of Sussex and Essex, and in the Pliocene beds of Norfolk, no doubt, as Mr. Clement Reid has suggested in the case of the Cromer "Forest bed" (10, p. 451), washed out of older strata.

The various fossil resins were orginally poured out from the tissues or sealed up in the cells and resin ducts of coniferous trees which covered a wide area of Northern Europe during the Eocene period.

Of this "Amber vegetation" we find an abundant supply of samples, both in the form of incrustations and petrifactions. In

[1] References to papers referring to Amber may be found in the works of Goeppert, Menge, and Conwentz, mentioned at the end of this paper.

many cases, where the resin has acted as an agent of petrifaction, we have plant-tissues preserved in wonderful perfection, sometimes rendering visible even nuclei in delicate parenchymatous cells, and giving us an insight into the minute anatomical structure of these Tertiary fossil plants, even more complete than that presented by the silicified Palæozoic plants of Grand Croix and Chemnitz, or the calcified remains in our English Coal-measures. In the form of an incrustation, Amber has no less distinctly preserved fragments of twigs, leaves, buds, and flowers; waifs and strays of Tertiary floras caught up in the slowly flowing resin or blown by wind and carried by animals on to the surface of the sticky exudations of resinous tissues.

The Amber which has rendered possible these microscopical examinations of fragments of a former vegetation, was present in the form of resin in ducts and receptacles scattered through the cortical and woody tissues of Conifers. In living trees, such as Pinus and many other Conifers, resinous secretions occur in lysigenous and schizogenous spaces; spaces, that is, due either to the absorption of groups of cells or to the gradual separation of uninjured cells. Resin is present, both as a normal product of the vital activity of healthy plants, and, in still greater abundance, as the result of wounds or injuries of various kinds which stimulate the secreting cells to abnormal activity and an increased production of resin. This abnormal occurrence of resin in living trees has been called by Frank *Resinosis*; for a similar phenomenon in the "Amber trees" Conwentz (2) proposes the term *Succinosis*.

Not only has the Amber been furnished by resins in horizontal and vertical ducts and spaces scattered through cortex, wood, medullary rays, and pith, but occasionally the well-preserved sections of Amber trees have revealed the existence of special groups of parenchymatous cells in the middle of woody tissues, and which have been set apart for resinous secretions. Occasionally, too, succinosis is seen in old tracheids of the wood whose membranes and cavities have become filled with resin, or in an unusually large number of schizogenous spaces in various parts of stems; the result of injurious atmospheric or organic influences which have made extra demands upon the resin supplies. If we picture to ourselves the thick Eocene forests in which animal and plant life was luxuriant and Nature worked with a free hand, it is not surprising to find that resinous material was produced on a larger scale than in the Pine woods of modern Europe where the forester's art and the altered climate have lessened the severity of the struggle for existence.

Dr. Conwentz, of Dantzig, whose recent monograph gives us full descriptions of the coniferous trees, the minute anatomical structure of which has been so clearly preserved by the resinous impregnations, prepared himself for the task of reading the Amber records by a careful study of the conditions of forest-life to-day, especially in

such cases where Pine woods spread unhindered over wide tracts of country. We may note some of the results obtained by an application of experience gained in recent forests, to the interpretation of the fragmentary relics of Tertiary forests.

In modern forests a variety of causes produce resinous exudations; resin ducts and receptacles are tapped by branches falling from the lower parts of stems where they are unable to secure their proper share of light and nourishment, and eventually decay and fall. A falling tree crashes through the branches of its neighbours; wind, storms, and lightning tear off branches or splinter stems. From all such causes resin receptacles are opened up and exudation results. The scars left by broken branches invite the attacks of animals and parasitic plants, which, in their turn, injure the living tissues and increase the flow of resin, which, softened by the sun's heat, may spread over the surface of branches and stems, enclosing in its course splinters and loose fragments of wood, and sealing them up, to be eventually entombed in hard, clear Amber. Insects, flowers, leaves, twigs, and light fragments, are carried by wind or other agency to the soft resin and embedded in it.

In addition to the Amber formed in this way, it has frequently happened that resin has been hardened and preserved in the ducts or cells from which it had never exuded. To compare the included insects and plants with living species is fairly simple, and such a comparison gives us a good idea as to the life in the Amber woods.

Leaving out of consideration the fossil insects, and avoiding detailed lists of plants, we may briefly refer to some of the better known or more interesting genera. Abundant evidence is afforded by plants of various families that the Amber flora flourished in a subtropical climate.

Beginning with Dicotyledons, we note the presence of such familiar genera as Fagus, Acer, Castanea, and Quercus, represented by leaves, flowers, fruits, &c.

In addition to these genera there are many others belonging to the same class, of which we may note some of the more familiar and interesting families.

CUPULIFERÆ.—Specimens of *Quercus* are common in the Baltic Amber; for the determinations of the various species we are chiefly indebted to Caspary and Conwentz. The pendant male inflorescence of *Quercus piligera* (Conw.) figured by Conwentz (3, vol. ii.) is a striking example of a fossil whose surface characters are seen through the clear Amber scarcely less distinctly than if a fresh flower were before us. In the same Family we have four species of *Castanea*, also leaves and floral organs of *Fagus*.

DILLENIACEÆ.—This tropical and Australian Family has a representative in *Hibbertia*, a genus native in extra-tropical Australia, whose leathery leaves with grooved and hairy lower surface are well shown in Conwentz's figures.

MAGNOLIACEÆ.—Two genera, *Magnolilepis* (Conw.) and *Magnoliphyllum* (Conw.), are referred to this tropical Family. In the LINACEÆ we have fragments of one species *Linum oligocenicum* (Conw.).

GERANIACEÆ.—*Geranium* and *Erodium* are both included by Conwentz in his list of Amber Angiosperms. Schenk has expressed a doubt as to Conwentz's determination of these genera; if they are rightly determined they are the first fossil examples of this temperate and subtropical Family.

ACERINEÆ.—Five species of *Acer* are mentioned by Conwentz.

SAXIFRAGACEÆ.—Two genera, *Stephanostemon* (Casp.) and *Adenanthemum* (Conw.), have been instituted to include Amber fossils referred to this Family. The recent genus *Deutzia*, native in China, Japan, and the Himalayas, is detected by the occurrence of flowers with characteristic stamens.

MYRICACEÆ.—A species of *Myrica* and a new genus *Myricophyllum* (Conw.) represent the two contributions of Amber to this Family.

AQUIFOLIACEÆ.—Three species of *Ilex* have been determined from well-preserved flowers.

LAURACEÆ.—The tropical and subtropical genus *Cinnamomum* has left remarkably distinct traces of its existence in the Amber flora. Specimens of exceptional beauty are figured by Conwentz (3, vol. ii.), in which are clearly shown the small valves or lids characteristic of the anthers of this Family.

EUPHORBIACEÆ.—The recent genus *Antidesma*, characteristic of warm latitudes, occurs for the first time in a fossil state as a well-preserved male flower in Oligocene Amber. Previous to this determination, the existence of Euphorbiaceæ in Tertiary times had been conjectured from leaf fragments which afforded evidence of little value.

PROTEACEÆ.—Species of *Persoonia*, *Lomatites*, and *Dryandra* are quoted by Conwentz as examples of this Australian and South African Family.

ROSACEÆ.—A flower included in Amber has been referred to this Family as a new genus *Mengea* (Conw.).

ERICACEÆ.—Leaf-bearing axes and fruits of *Andromeda*, a North American and North Asiatic plant, occur in the fossil resin; other genera also are referred to the same Family.

CAPRIFOLIACEÆ.—Two species of *Sambucus* are figured with floral organs in good preservation.

LORANTHACEÆ.—Representatives of the Mistletoe Family occur in *Patzea* (Casp.) and *Loranthacites* (Conw.). The former genus, originally described by Goeppert and Berendt as Ephedrites, and considered to be closely related to the recent genus *Ephedra*, has since been recognised by Conwentz, Caspary, and Schenk as one of the Loranthaceæ. Its characters are well illustrated in the figures of flowers and flowering branches given by Schenk in "Zittel's

Handbuch" (7, p. 713). This extinct form *Patzea* has its nearest living representative in the genus *Arceuthobium*, a parasitic Angiosperm of the Mediterranean, North American, and other regions. The oldest known examples of the Loranthaceæ are those mentioned by Saporta in the list of fossil plants from Lower Cretaceous strata of Portugal.

Among the Monocotyledons we may mention representatives of four families.

Liliaceæ.—*Smilax* has been detected from a well-preserved female flower.

Palmæ.—Four species of Palms are included in the Amber Monocotyledons, belonging to the genera *Phœnix*, *Sabalites* (Casp.), *Bembergia* (Casp.), and *Palmophyllum* (Conw.).

Araceæ and Gramineæ.—Three new genera have been instituted to include fragments referred to these two families.

We have not to trust, in the case of Amber flowering plants, merely to doubtful determinations based upon fragmentary leaves, but are dealing with flowers and fruits which the Amber has sealed up, and in a condition which allows of little or no doubt as to their true botanical affinities. To form some idea of the perfect state of these flowers, buds, leaves, and twigs, one has only to look at the excellent figures of Conwentz and previous writers, in which are seen sepals, petals, stamens, and pistils still in their places, and apparently as complete and distinct as if just gathered from the living plants. Another interesting example of flowers which have left similar relics of their delicate structures is that of the Sezanne tuffs of Eocene age (8, p. 6), in which perfect moulds have been left by the embedding and subsequent removal of the flowers in a calcareous matrix : wax introduced under an air-pump into the moulds, and after the removal by acid of the surrounding travertine, forms casts of the floral organs of the flowers. Specimens of these wax casts are doubtless familiar to those who have examined the collections of fossil plants in some of the Paris Museums.

*Gymnosperms* are especially abundant in the Baltic Amber, and the coniferous stems, roots, and branches furnish us with striking examples of Amber petrifactions. In the form of large pieces, or as small fragments, the wood and bark of Pines and other Coniferæ have been thoroughly impregnated with resin, which in its Amber condition allows us to examine microscopically the most minute structures in the tissues of these Amber trees. In addition to the vegetative parts of Conifers, male and female flowers, and even pollen-grains, are frequently found.

Many of the Amber Conifers belong to genera which have retreated since Tertiary times to more congenial extra-European latitudes.

Male flowers of Abietaceæ are mentioned by Conwentz (2) as common, and their frequent occurrence is explained by the fact that

they fall from the trees after their function has been fulfilled, at a time when resinous exudations would be plentiful, and in a condition suitable for the reception and embedding of foreign bodies.

The Californian genus *Sequoia*, the Japanese genera *Sciadopitys* and *Libocedrus*, the Swamp-Cypress (*Taxodium distichum*) and others afford examples of Conifers lost to Europe since the Tertiary period. In addition to those already alluded to, species occur of *Thuja*, *Abies*, *Juniperites*, *Picea*, *Cupressus* and other genera.

The great majority of the fragments of coniferous wood from the Baltic Amber have been referred to *Pinus succinifera*, a species whose various tissues have been fully described by Conwentz and previous writers; in certain anatomical details this species resembles varieties of the recent Conifer *Pinus laricio*, but in certain points stands alone as a characteristic and extremely common Pine of the Amber Flora.

From an examination of the forms and structural details of fragments or splinters of the wood of Pinus and other trees, it has been shown by Conwentz how it is possible to arrive at conclusions in many cases as to the conditions under which the splinters were formed. For such a work as this a close study of living trees is a necessary preparation. Pieces of wood torn off stems and branches by the impact of falling trees, or broken off by wind, have certain peculiarities in shape and microscopic structure which distinguish them from splinters struck off by lightning: the action of the latter is recognised by the torn membranes of the wood elements, and by the general form of the splinters, the action of wind and falling trees, &c., splits off fragments of wood whose component elements are for the most part whole.

Occasionally pieces of Amber show distinct signs of burning, suggesting by their charred appearance the burning of forest fires ignited by lightning flashes. In looking through microscopic preparations of English Coal-measure plants, one sometimes notices tissues in which the cell-walls are black and apparently charred, strikingly suggestive of the action of fire (9 $\beta$, Pl. 33, fig. 19).

Another phenomenon which is brought out by the microscopical examination of tissues in Amber is named by Conwentz (2) "*Vergrauung*." This consists in the loosening or partial separation of tracheids imparting to the surface of the wood a certain woolly or hairy texture. The same phenomenon may be seen on the exposed surface of Pine-wood shingles used in the roofs of country houses in the hilly districts of Germany and other countries; the fresh smooth surfaces after a time lose their freshness and become woolly as the result of this "Vergrauung" process.

Instances are recorded of double "annual" rings in stems and Amber trees. Among living trees, Kny (5) has described a case of double rings in *Tilia parvifolia*, whose leaves were eaten by caterpillars about the end of June, and this caused a premature development of the next year's buds. The branches on which these leaves had

been unfolded showed in the year's wood two rings instead of one. These double rings in the Amber woods may probably be referred to some cause similar to the one noticed by Kny. *Parasitic Fungi* are common in the tissues of the various trees; their abundance points to a plentiful supply of moisture, and a temperature warm and congenial for such parasites. Among other Fungi, *Polyporus* and *Trametes* have left characteristic traces in the Baltic Conifers. Not only are their hyphæ found ramifying in tracheids and cells, but signs of their ravages are apparent in the broken-down elements of wood and cortex. Spores of Fungi distributed by wind and animals would readily effect an entrance into the tissues of their hosts, where fallen branches or the gnawing of animals exposed unprotected places on stems, roots, and branches.

Not only are there abundant records of parasitic Fungi in the Amber plants, but remains also of *Saprophytes* have been found in fragments of fallen and partially-decayed stems and branches.

Hyphæ of fossil Fungi have been noticed in fossil tissues of various geological ages; in the Coal-measures one finds them occasionally in the cells and tracheids of Lepidodendra and other plants. The well-known *Peronosporites antiquarius*, figured and described by more than one writer, is a good example of a Palæozoic Fungus (9 a).

It is not the object of this paper to enumerate all the organisms of whose presence in the Eocene Forests Amber affords direct or indirect evidence. The existence of numerous spiders and insects, such as Butterfly larvæ and Beetles, is shown both by their remains sealed up in the fossil resin, and by their excreta and traces of their activity in borings or other markings in the woody and cortical tissues. In many microscopic slices of coal plants we may detect proofs of the existence of xylophagous animals in their excreta lying in cavities eaten out of the sound tissue (11). Higher animals have left equally distinct signs of their existence, sometimes in the form of hairs, or, in one or two cases, feathers embedded in Amber, sometimes in characteristic markings on bark and wood, and in the abnormal growth of tissues consequent upon wounds inflicted by animals in search of food.

Among other animals, the Squirrel, and a bird closely allied to the recent Woodpecker, may be mentioned as two examples of the Forest fauna which have been recognised in Baltic Amber.

From this general and incomplete sketch of Amber and some of its included fossils, we realise, to some extent, how important have been the investigations of the resinous petrifactions and incrustations as a means of focussing before us the life and conditions of Eocene forests whose remains have afforded such abundant supplies of Amber in the Oligocene beds of the German Samland.

In the ingenious methods employed by Conwentz in his microscopical examination of tissues fossilised in Amber, we have another instance of the value of Palæobotanical work. When supported by a

wide knowledge of recent vegetation, it affords not only a general view of ancient life, but enables us to sketch out the biological and physical conditions which made up the life of Tertiary forests whose scattered fragments were swept along by streams and rivers, to be eventually buried in marine sediment. Their subsequent gradual upraisal has brought them to light as relics of a past age, whose records, if read aright, carry us back to a geological period when Europe presented an aspect very different to that under which we are accustomed to regard it.

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A. C. SEWARD.

# SOME NEW BOOKS.

A NATURALIST IN THE TRANSVAAL. By W. L. Distant. 8vo. Pp. xvi. and 277, with thirteen plates (four coloured) and other illustrations. London: R. H. Porter, 1892. Price 21s.

IN this book, Mr. Distant gives us the results of his leisure during twelve months spent in the Transvaal on business. South Africa is a well-worked field, but Mr. Distant's observations have brought to light many new and interesting facts, while his collections have largely increased our knowledge of the insect-fauna of the district. The new species are described in an appendix to which many specialists have contributed. The only new vertebrate is a snake (*Glauconia distanti*, Blgr.), the greatest amount of attention having, naturally, been given by Mr. Distant to the insects, in several orders of which numerous forms found by him have been hitherto unknown.

The change which has come over the modern naturalist's view of nature is emphasised in the following passage:—"I could not help contrasting the different mental conceptions which dominated me when collecting in the Malay Peninsula twenty-two years previously, and those which now dominated my mind in a similar quest at Durban. Then, almost the sole aim was the discovery of new species; now, the constant wish was to make some small discovery to add to the ever-increasing knowledge of how animals derived their present shape and coloration in the struggle for existence." Accordingly, our author has given us various notes on protective resemblance and mimicry. The butterfly *Hamanumida dædalus* has been observed in West Africa to rest on the ground with closed wings the under surfaces of which vary in their markings to harmonise with different soils. In South Africa, however, Mr. Distant always found this insect resting with expanded wings, so that the upper surface was exposed, and assimilated to the colour of the greyish rocks and paths. The well-known *Danais chrysippus* was found in abundance accompanied by *Hypolimnas misippus*, whose female is so perfect a mimic of it. The distasteful qualities and warning coloration of the *Danais* afford it such protection that Mr. Distant enquires why it does not absolutely swarm, and suggests "some inherent weakness or danger which produces great mortality in the early stages." An enemy of this butterfly has been discovered by Mr. Distant in one of his new orthopterous insects, *Hemisega prædatoria*, which lurks among the tops of tall grasses to which it bears "aggressive" resemblance, and is thus enabled to seize the *Danais* when it settles on the flower. One specimen of *D. chrysippus* was obtained with wings mutilated as if by the bite of a bird, which was probably driven by hunger in the dry season, when insects are very scarce, to attempt a meal on the nauseous butterfly.

The appearance of insects as the wet season comes on is described with much interesting detail, and the contrast drawn between the

"veld" in drought and in rain is striking. The sudden rise of the watercourses ("spruits") is often a source of danger to travellers, though it must afford a grand object-lesson to geologists on the force of denuding agencies.

There are some notes of interest on birds. Mr. Distant tells us that the reputed fine of fifty pounds for killing the snake-eating Secretary-Bird (*Serpentarius secretarius*) is a myth, and that one was secured after three miles' chase on horseback, a fact which shows that the bird can run sometimes at least without breaking its legs. The heavy flight of the male Widow-Bird (*Chera progne*) in the breeding season is noted, its long tail being a great encumbrance, and, according to Mr. Distant, an example of the production of a disadvantageous structure by sexual selection.

On mammals, Mr. Distant has not much to say, except to deplore their extinction. The former magnificent antelope-fauna has been almost destroyed by the persistent attacks of the Boers, and the carnivora have necessarily much decreased in numbers. The prevalence of spiny acacias and hard-wooded trees is the only sign to-day that multitudes of herbivorous mammals once dwelt in the land.

Savage and civilised men alike receive attention. The Magwamba Kafirs are described in some detail, and Mr. Distant has formed a favourable opinion of the native character. A chapter is devoted to the Boer of whom our author gives what seems to be a fair and impartial criticism. It is not the Boers, however, but the English and recent Dutch and other European settlers who will make the future prosperity of the Transvaal; and, curiously, the modern Dutch emigrant is hated by the Boer. The gold and diamond mines have attracted some very undesirable speculators into the country, and some of the stories of gains and losses told by Mr. Distant are interesting and instructive. His sketches of colonial character are fresh and racy.

There is an evolution in human dress as well as in animal organs, and we are told that, in Pretoria, tall white hats distinguish lawyers and doctors, while the President is the only wearer of a tall black one!

The book is well got up, and the illustrations are very good. It is rather startling, however, to read (p. 107) about "*Galileos* who cared for none of these things"! G. H. C.

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BREHM'S TIERLEBEN.—Third edition. Edited by Professor Dr. Pechuel-Loesche. —Die Kriechtiere und Lurche. By Dr. Alfred C. Brehm. New edition by Professor Dr. O. Boettger and Professor Dr. Pechuel-Loesche. 8vo. Pp. 825, with 167 engravings, 1 map, and 16 plates. Leipzig and Vienna: Bibliographisches Institut, 1892.

A THIRD edition of the celebrated work, "Brehm's Tierleben," is now in course of publication, under the able editorship of Professor Pechuel-Loesche, and we have just received the seventh volume, dealing with the Reptiles and Batrachians. For the preparation of this volume the editor has had the good fortune to secure the co-operation of Professor Oscar Boettger, one of the most distinguished of modern herpetologists. To Brehm's admirable descriptions of the habits of these animals, Professor Boettger has added much of his own observations, and brought the work thoroughly up to date as regards the systematic aspect, and thus raised it much above the usual standard of popular Natural Histories. In fact, as it now appears, Brehm's volume on the Reptiles gives not only an unequalled account of the

habits of this interesting group of vertebrates, but serves as a most useful book of reference to all interested in the classification and geographical distribution of recent Reptiles and Batrachians. So thoroughly has the revision of this volume been carried out, that even the results of observations recorded within the last few months have found their way into its pages. So often do we find books of a popular character inaccurate and behind date, that we cannot speak


FIG. 1.—*Psammodromus algirus*, from the Western Coasts of the Mediterranean. The specimen figured above represents the recently described *var. nollii*, from Algeria.

too highly of the value of a work such as the present one, which combines elegance of style with the strictest scientific accuracy.

We are pleased to find the classification in the volume before us conform to that adopted in the rearrangement of the collections in the British Museum. Thus, Snakes are no longer primarily divided into poisonous and harmless; the Slow-worm finds its place near the Sheltopusik and the Glass-snake of North America,

instead of being associated with the Scinks; and adaptations to the different modes of life are considered as subordinate in classifying the Chelonians and Batrachians. The characters of all families (with but a few exceptions) and higher groups are given; and the maps, showing the geographical distributions of the various groups, will prove most useful, drawn up as they are by so competent an authority as Dr. Boettger from the latest data available.


FIG. 2.—*Ceratobatrachus guentheri*, the horned frog of the Solomon Islands, discovered by Dr. H. B. Guppy.

A large number of new figures, mostly from the skilled pencil of Mützel (two of which we are able to reproduce through the courtesy of the publishers), have been added, some to replace less satisfactory ones in the previous edition, others to represent little-known or newly-discovered forms. Among the new figures, we notice excellent representations of *Anguis fragilis*, *Rana arvalis*, and other German species, all of which are now figured in the "Tierleben." A few of these

new engravings may, however, evoke some criticisms. It is doubtful, for instance, whether the representation of *Rana agilis* will afford much help in the recognition of this rare frog in Germany; and the new figure of *Heloderma*, the poisonous Lizard, which represents *H. suspectum* (not *H. horridum*, as stated in the letterpress), is inferior to the old one. The figure given on p. 146 as *Lacerta agilis* is surely taken, magnified, from *L. vivipara*, as correctly stated in the former editions; the snake on p. 467 is apparently *Vipera russellii*, not *Ancistrodon rhodostoma;* and the representation of *Ceratophrys boiei* on p. 690, stated to be of the natural size, is much enlarged, the frog, so far as we know, not exceeding a length of 3½ inches.

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Property: Its Origin and Development. By Ch. Letourneau. (The Contemporary Science Series.) 8vo. Pp. xii., 401. London: Walter Scott, Ltd., 1892. Price 3s. 6d.

If this work dealt with the origin and development of property simply from an historical point of view, it would merit no notice in this magazine. Professor Letourneau, however, is an anthropologist of the modern school, fully alive to the value of the ethnographic method, which, in the spirit of Natural Science, seeks to explain the evolution of social institutions by an appeal to the manners and customs of the lower races. What these races now are, such it may be assumed in broad terms our ancestors once were. Those who refuse adhesion to this fundamental tenet need not concern themselves with the study of the present volume; since, disagreeing radically with the author's method of enquiry, they will, of necessity, refuse to accept his conclusions. Those, on the other hand, who have faith in the simple method of seeking to interpret the unknown past of our civilisation by a consideration of the present condition of less civilised peoples, will find in Professor Letourneau's volume a storehouse of information and suggestion on some of the most interesting problems of sociology.

The desire of appropriation, whence springs the origin of property, seems referable to the imperious instinct of self-preservation, and is consequently common enough in the animal world. Man is proverbially an acquisitive animal, but other animals are largely acquisitive, and the naturalist will have no difficulty in multiplying the instances cited in the early part of this volume. When the shrike forms a collection of impaled victims, the creature provides, with instinctive foresight, for the wants of the morrow, much as a savage may hoard his food when fortune brings him more than is required to supply his daily need. House property is also common among birds and other animals, and even the possession of landed property is recognised in a certain sense. A strong animal, like a lion, may lay claim to a certain area as its hunting-ground, and be prepared to defend his right, in truly leonine fashion, against all intruders. Primitive man, on the contrary, would generally be too weak, single-handed, to defend his own area against the invader; hence he was led to associate with his fellows for the defence of common property. Isolation meant death; weakness led to union, and union to strength. Once in possession of conscious strength, a man's egoism asserts itself, and, gradually becoming forgetful of his obligations to his associates, he grows discontented with communal property and yearns for private possession. One man,

stronger than the rest, gains the ascendancy; individualism triumphs over altruism, and private ownership of land is established.

Private property was probably, in the first instance, of a strictly personal character. The weapons and ornaments which a man had made for himself were clearly his own belongings, and were consequently buried with him for service in the next world. When man passed from the condition of a hunter to that of a herdsman, his property took the convenient form of domesticated animals. Passing, in the course of ages, from this nomadic life to the settled life of an agriculturist, he acquired landed property which, as already explained, would be at first of a communal character. The solidarity developed in a village community led to a certain kind of altruism, and thus acted as a check upon egoism. But eventually an inverse process would be carried out; the soil became parcelled out into allotments, the cultivator enjoying merely the usufruct of his plot. Gradually, however, the chieftains would manage to transfer this right into property transmissible to their descendants, and such a practice would be imitated as far as possible by the more powerful of the community.

With the historic phases of the subject, such as the development of the feudal system, we have no concern in these pages; neither do we feel at liberty to refer to the author's views on the future of the right of property. For these, and many other topics, we must refer to M. Letourneau's volume—a volume which will be read with much interest by all who are busied with the fascinating problems of evolutionary sociology.

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THE OPTICAL INDICATRIX, AND THE TRANSMISSION OF LIGHT IN CRYSTALS. By L. Fletcher, M.A., F.R.S. London: Henry Frowde, 1892.

EVERY geologist who occupies himself with the study of rocks is familiar with the practical determination of minerals by their optical characters, and has found it necessary to acquire some knowledge of Fresnel's wave-surface; he is also probably aware that the method used by Fresnel in his marvellous memoir on double refraction has long been regarded as dynamically unsound, and that the nature of the luminiferous ether has lately been the subject of much investigation and discussion on the part of physicists.

Now, in his quest for instruction regarding the optical characters of crystals, the student is first confronted with the elastic properties of the luminiferous ether, and then with the deduction of the wave-surface by Fresnel's method; and yet if he has ever endeavoured to do so, he has probably failed to form any distinct conception of the plane waves on which that method is based.

A further difficulty will encumber the progress of any thoughtful student when he discovers that various elastic theories of the luminiferous ether have been devised, and yet that they all lead to the same wave-surface.

Mr. Fletcher's little book will not attract the attention of the general reader, because, being specially intended for the student, it is thrown mainly into a mathematical form; it is, therefore, all the more desirable to indicate the educational value of this extremely ingenious treatise.

The book is nothing less than a bold rejection of the recognised methods of teaching this subject, and the substitution of a new and original treatment of striking geometrical elegance which involves

no higher mathematical knowledge than appertains to the study of the ellipsoid.

In an interesting piece of historical criticism, Mr. Fletcher shows that Fresnel did not really deduce the wave-surface from his theory of the elastic ether, as is commonly supposed, but by a generalisation from the empirical results of Huggens; and he makes it clear that any theory which supposes light to travel in straight lines (rays) and to be due to a periodic change, whether a wave motion or other disturbance, at each point of the ray, must with the aid of certain natural assumptions lead to the same wave-surface.

Discarding, therefore, entirely any assumption regarding the physical constitution of the ether, he deduces the optical characters of crystals by an entirely new and extremely simple geometrical method from the Optical Indication, which is really nothing more than the ellipsoid (spheroid or sphere) familiar to physicists as the Ellipsoid of Polarisation of Cauchy. The simplicity of the method is greatly enhanced by the exclusive use of rays and not waves throughout the process.

We venture to predict that those students who are sufficiently courageous to master the first four chapters of Mr. Fletcher's treatise will not only find a lucid and logical explanation of the nature of crystalline double refraction, but will obtain an insight into the historical development of the subject which will be of vast assistance in the study of the writings of other authors.

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Anniversary Addresses to the Geological Society of London, 1891 and 1892. By Sir A. Geikie, F.R.S. (*Quarterly Journal of the Geol. Soc., Proceedings*, vol. xlvii., pp. 48–162, and vol. xlviii., pp. 38–179).

In his presidential address to the Geological Society of London, in February, 1891, Sir Archibald Geikie set before himself the task of presenting "a general outline of the whole volcanic history" of the British Isles; and this outline has just been completed by the publication of his second address in May of the present year. As the author remarked, "placed on the edge of a continent and the margin of a great ocean-basin, the site of Britain has lain along that critic a border-zone where volcanic energy is most active and continuous;" and the records which he unfolds show a recurrence of volcanic phenomena in the west and north-west of the area, even after very long intervals of time. Thus, the Exeter eruptions being referred back to the Permian, the whole Mesozoic era passed without external manifestations; yet in early Eocene times the outbreaks again began on the continental border, giving us the plateaus and necks of Antrim and the Inner Hebrides.

Beginning in his first address with the Archæan masses, the author well states his position when he accepts "the term 'Archæan' as a general designation for the oldest gneisses and their associated rocks," and observes that he is unaware "of any reason why rocks undistinguishable in composition and structure from Archæan masses may not be found in much younger formations." The Lewisian gneiss is regarded as "originally a mass of various eruptive rocks," which may or may not have given rise to volcanic products at the surface. Certain pebbles of true lavas occurring in the Torridon Sandstone may actually be relics from volcanoes of Archæan age.

In discussing the "younger schists" a new term is introduced.

The schists of the central Scottish highlands, with included quartzites and limestones, and the lithologically similar rocks of Donegal, Mayo, and Galway, are named *Dalradian*, from Dalriada, a north Irish kingdom that sent out very successful colonists into Scotland. Like the American "Algonkian," this may come to be a very useful term, if confined, as its author would desire, to the localities in which it has originated. Sir A. Geikie, in cutting off this group from the Archæan, admits that it may contain rocks of various ages, from Archæan to Upper Cambrian; "sills" of igneous rock occur on a number of horizons in it, and in Co. Tyrone coarse volcanic agglomerates and lavas are recorded at its base.

Anglesey comes in for an interesting discussion; a core of Archæan gneiss is admitted "with some confidence"; and the schists are regarded as a metamorphosed clastic series, referred to the Dalradian, and including the quartzite of Holyhead Mountain. The important announcement is made that this latter rock is crowded with annelid-pipes; whether these are Precambrian or Lower Cambrian must be left an open question.

All through this portion of the address one sees a growing tendency to assign a Precambian age to the Torridon Sandstone, though this is not expressly stated; in fact, the officers of the Geological Survey only proved this point a few months later. While dealing with volcanic rocks, question after question of this kind has confronted the author; and the fear is that stratigraphical assertions or admissions of a most important character occurring in this address, may be overlooked by general workers, owing to their being interwoven with details of a more petrographic nature. Let us at once say that no one interested in the Precambrian controversy can afford to be without the address of 1891.

The candid acceptance of the views of critics of the older work of the Geological Survey is noticeable in the treatment of successive systems; but the acceptance or rejection of such criticism has been fairly based by the author on a review of the evidence in the field itself. Dr. Callaway's term "Uriconian" is thus adopted for the Wrekin volcanic series; and the great eruptions of the Cader Idris area are believed to have broken out in Tremadoc times, attaining their great development in the Arenig. The suggestion of a basal volcanic agglomerate in the quartzites and shales of Howth has already called forth a rejoinder from Professor Sollas, read recently before the Royal Dublin Society.

The second address, delivered in February, 1892, opens with an extensive account of the Old Red Sandstone volcanoes. Trachytes are recorded from near Jedburgh; and still more typical examples are described later, with analyses, from the Lower Carboniferous of the Garlton Hills, the rock of Traprain Law being regarded by Dr. Hatch as a phonolite. Interest attaches to the volcanic necks in the S.W. of Scotland which traverse the Coal-measures; others are correlated with these, and a Permian volcanic series is established. As already mentioned, the andesites in the red rocks of N.E. Devon are removed, somewhat conjecturally, from the Trias back into the Permian.

The Tertiary volcanoes are dealt with more summarily, owing to the author's important paper on this subject in the *Transactions of the Royal Society of Edinburgh* (1888). He maintains that the more acid rocks of Skye and Mull are intrusive both in the basalt plateaus and the gabbros, which have been usually regarded as the later series;

but the point is conceded that the rhyolites of Co. Antrim (still styled "trachytes") are at any rate older than "the later half of the basalts." On this, as on other matters, more may still be said; the two addresses contain so much that is new, interspersed amid summaries of older work, that criticism must be left to observers in special localities, while all readers will profit by the comprehensive view now given them.

G. A. J. C.

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WITHIN AN HOUR OF LONDON TOWN. By a Son of the Marshes. Edited by J. A. Owen. 8vo. Pp. 314. London and Edinburgh: William Blackwood and Sons, 1892.

"WITHIN an Hour of London Town," is not in any sense a scientific work, nor does it possess much originality. Its special charm lies in the wealth of language, rich and varied, but seldom forced or unnatural, which carries us rapidly away from the noise and rattle of City life, into the retired haunts of the "fern owl," the green woodpecker, and other interesting birds, whose habits will always repay the investigations of a quiet eye. There is just a flavour of censoriousness in the present volume, savouring a trifle too much of self-consciousness, but this is too well concealed to detract seriously from the value of its fascinating pages. Lovers of pets will revel in the description given of the habits of a Little Owl, though, remembering the numbers of this species imported into London every year, we cannot think that the little pet of "the Son" had really crossed the Channel by his own election. Chapters on "Autumn Lights and Shades," and "Winter Shifts" are strongly imbued with that healthy insight into the ways of wild creatures which is one of the growing signs of the times.

A large proportion of the book consists of the commonplace talk of country folk. This is often good of its kind, but it soon palls, and a little of it goes a very long way with most people. The author gives a long disquisition on the Hawfinch eating peas, but he has entirely forgotten to say that it consumes large quantities of injurious insects during the spring and summer. Its wholesale destruction, as described by the Son of the Marshes, is a direct defiance of the Wild Birds Act, and entirely opposed to the dictums of common sense. One female Hawfinch, shot near her nest in Kent, proved on dissection to contain—not green peas, but forty injurious caterpillars. Yet the author of this work seems almost to approve of its destruction.

We notice that the author occasionally becomes confused between allied species. For example, at p. 153 he identifies the Nearctic Buffel-headed Duck with the Goldeneye. At p. 163 he tells us that punt-gunners *do not shoot together*. Unfortunately, *many of them* shoot together, and share their luck together. The foot-note on p. 11 seems to imply that the term "gabble retchet" is applied to wild geese in Surrey. As a matter of fact, the expression only obtains (so far as we know) in Yorkshire, and the whole note is borrowed property. But we have no wish to find fault with the fare provided for us in this volume. It was a good idea to reprint the articles here gathered together from the *Times* and the monthly magazines. Such essays deserve to be encouraged, because they supply a pabulum of the daintiest and most airy kind for our play-hours.

ATLAS OF PHYSICAL GEOGRAPHY: illustrating in a series of original designs the elementary facts of Chartography, Geology, Topography, Hydrology, Meteorology, and Natural History. Edinburgh and London: W. & A. K. Johnston, 1892. Price 12s. 6d.

THIS new edition has been thoroughly revised under the supervision of Sir Archibald Geikie. It comprises 24 plates, with accompanying letterpress. Of these plates nine are entirely new. They include neat Geological Maps of the British Islands, Europe, and North America; a Map of the World, showing heights of the land and the depths of the Ocean-basins; Maps showing Isobaric Lines, and Prevailing Winds of the World for January and July, Climatological Charts of the World for January and July; and a Chart of the World, showing the forms and directions of the Ocean Currents.

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THE STORY OF THE HILLS: A Popular Account of Mountains and How they were Made. By Rev. H. N. Hutchinson, B.A., F.G.S. Pp. 357. Illustrations. London: Seeley & Co., 1892.

FEW popular writers on Geology have surpassed Mr. Hutchinson in clearness of style combined with accuracy of expression, and we commend his new volume to the notice of all who desire a short general exposition of the subject of mountains. It is a work that will interest the most casual reader, and convey much solid information in a pleasant form. The first third of the book deals with mountains as they are; the second two-thirds are devoted to purely geological matters. Most of the illustrations are reproduced from fine photographs of scenery.

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THE last number of the *Proceedings of the Zoological Society* (1892, pt. i., issued June 1st), contains a number of papers on systematic zoology, including papers on the Mammals, Reptiles, and Batrachians of Barbary, by Dr. Anderson; of the Myriapods and Arachnids of the same region, by Mr. Pocock. Mr. Thomas revises the Hyracoidea, and Mr. Sclater has two papers on African Mammals. Additions to the Insect fauna of Borneo and Africa are made by Messrs. Butler, Gorham, and Gahan. Worms occupy considerable attention, three of the most interesting papers in the number relating to this group, and are contributed by Mr. Beddard and Dr. Benham. The paper of most general interest is a very heterodox paper by Mr. W. Bateson, in which he maintains that the present idea of Homology is imperfect and "founded on a misconception of essential facts"; he points out that the current theory ignores variation, or assumes that any such variation respects the individuality of each member of a series of structures such as teeth: he shows by an extensive series of illustrations that variation is not confined within any such narrow limits. Mr. Lydekker describes a Sirenian jaw from the North Italian Aquitanian (Oligocene), the nature of the teeth of which afford strong evidence in favour of the order Sirenia having been evolved from some Artiodactyle Ungulate with selenodont teeth. By adoption of new and improved methods of treatment, Mr. M. F. Woodward has succeeded in settling the old question of the dentition of Hyrax; it is interesting to note that his work was mainly done on the specimens used by Professor Huxley in his well-known paper of 1863.

# NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

The removal of the Natural History collections at Prague to the new building of the Royal Bohemian Museum is now in progress. The cases, however, are not yet completed, and nearly all the specimens are thus packed in boxes. The difficulties are also much increased by the very limited staff at the disposal of the Director, Dr. Anton Fritsch. A special room 25m. in length by 12m. in breadth, to be termed the "Barrandeum," has been appropriated for the exhibition of the late Dr. J. Barrande's collection of fossils illustrating his "Systéme Silurienne de la Bohême;" and we are pleased to learn that the Barrande Fund, founded by Dr. Anton Fritsch for the further encouragement of the work that ceased at Barrande's death, has now reached the sum of 10,000 florins. The interest on this fund, which has been raised by voluntary contributions, will be available next year for the endowment of research in the Silurian Formation of Bohemia, and it is hoped that some palæontologist will be thereby induced to make important additions to our knowledge of the smaller fossil organisms of that Formation.

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The Annual Report of the Vienna Museum of Natural History for 1891 appears in the new part of its *Annalen* (vol. vii., pts. 1, 2). In addition to the detailed lists of acquisitions and publications, and the general report of progress, there is an interesting brief account of the various scientific missions undertaken by members of the staff in foreign countries. These missions form one of the most noteworthy features in the work of the Vienna Museum, and during 1891 the costs of no less than eight journeys were defrayed from the fund at the disposal of the Director. Dr. Franz Steindachner's exploration of the depths of the Mediterranean in the Grecian Archipelago, under the auspices of the Vienna Academy of Sciences, is also an important feature in the year's work; and his subsequent co-operation with Dr. R. Sturany in the investigation of the fauna of some freshwater lakes in Macedonia resulted in the acquisition of a valuable collection from a previously unexplored region. Among future arrangements, Dr. A. Brezina is deputed to represent the Museum at the Scientific Congresses in connection with the Chicago Exhibition next year. Few changes were made in the staff of the Museum during 1891, and numerous congratulations were offered to the esteemed Director, Dr. Franz Ritter von Hauer, on the occasion of his seventieth birthday.

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The Annual Report of the Brighton Museum for 1891, lately issued, records much progress in the arrangement of the Natural History collections, which are now very extensive. The most important addition during the year was the series of Brachiopoda, Bryozoa, and Tunicata selected and arranged by Miss Agnes Crane. In response to a request from the Secretary of the British Association Committee for the Registration of Type-Fossils, Mr. Edward Crane, Chairman of the Museum Committee, has prepared a list of the type and figured specimens of fossils, which is appended to the Report. The unique collection of fossils from the Sussex Chalk, presented to the Museum by Mr. Henry Willett, is especially rich in such specimens; and the Holmes Collection of Wealden Reptilia comprises several bones described by Sir Richard Owen.

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The sixth International Geological Congress is to be held at Zurich in August, 1894. A preliminary circular, signed by Professors Renevier, Heim, and Golliez, has already been issued, together with a brief *Procès-verbal* of the meeting held on the 3rd

August, 1891, at Salzburg, which was concerned with certain European geological maps. Considering the nature of their country, the Swiss geologists are arranging two kinds of excursions, some across the Jura and the Alps, for those "accustomed to long walks," and others for the less sturdy, during which steamboats, railways, and other conveniences will be utilised. Full particulars will be furnished later. The meetings will be held at Zurich, but the excursionists will reassemble at Lugano for the final meeting of the session.

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MR. BERNARD HOBSON, M.Sc., has been appointed Assistant Lecturer on Geology in the Owens College, Manchester. Mr. F. R. C. Reed succeeds the late Mr. Thomas Roberts as Assistant to the Woodwardian Professor of Geology at Cambridge, and Mr. H. Woods has been appointed Demonstrator in Palæobotany in the same university.

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THE foundation-stone of an institution destined to include a Public Library, Museum, and School of Science and Art, was laid at Carlisle on May 26. The cost, amounting to £18,000 or £20,000, has been raised partly by public subscription, partly by a contribution from the funds at the disposal of the Town Council.

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THE Annual Report of Mines for the Midland Counties for 1891 has recently appeared. The district inspector, Mr. A. H. Stokes, states that the amount of coal raised, 21,569,161 tons, is the largest quantity ever yielded by the Midland collieries in one year, and exceeds that of 1890 by over a million tons. Classes for instruction in mining have been formed, and appear to be appreciated in Nottinghamshire and Warwickshire.

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DR. FORTNUM'S offer of the remainder of his collection of antiquities and works of art to Oxford University was accepted by Convocation on 14th June. The collection was offered, together with £10,000, on condition that the University should build a new Ashmolean Museum, close to the University galleries, at a cost of £11,000, an additional £4,000 for fittings being included in Dr. Fortnum's will. A further condition is that the University provide £300 a year, which, added to the interest on Dr. Fortnum's £10,000, will suffice to keep the whole in good order. The alterations will relieve the Bodleian Library, and improve the Taylorian Institute and the galleries, by the addition of the new museum.

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THE second International Zoological Congress will open at Moscow on August 22. Arrangements are being made for excursions around Moscow, towards the Caucasus, the Urals, and Turkestan, but these depend on the number of names sent in. A reduction of 50 per cent. has been granted to the members of the Congress on all the Russian railways.

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THE "Association française pour l'avancement des Sciences" will meet this year at Pau, from the 15th to the 22nd of September. The American Association meet at Rochester, N.Y.

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As a frontispiece to Professor Flower's book on "The Horse," noticed in our issue for March, a figure of the skeletons of a man and a horse are given. The skeletons themselves may now be seen in the mammalian alcove of the vestibule of the Natural History Museum, and will be found of much assistance to the student of comparative osteology. The bones in both are labelled, and around the half of each skeleton a mould of the skin is placed which enables the observer to understand the relations of the bones to the external form of the living animal.

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MR. N. OKOSHI, Acting Consul-General for Japan, has been requested by his Government to pursue enquiries as to the organisation of the various museums in this country, with special reference to the artistic and scientific establishments. The

Tokio University having proved a successful and flourishing institution, the Japanese Government is turning its attention to the subject of national museums. In noticing this, the *Birmingham Post* comments on the increasing tendency to use the English language for scientific publications of international interest, and refers to the publications of the Tokio University and to certain serials of Sweden, Norway, and Holland as being in that language. The Tokio University publishes both in English and in the vernacular, and both series have been seen at the Natural History Museum. The wise plan of publishing abstracts of lengthy papers in some generally understood language, such as German or French, has for long been followed by the Russian and Hungarian scientific journals, while many papers published originally in Polish are later on printed again in German. Unless this were done, the task of reading the numerous memoirs on certain subjects would be a hopeless one, and much valuable information would be useless, except to a few, the knowledge of three to five Western European languages being a fair accomplishment for the average scientist.

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THERE has lately been established "The Institution of Mining and Metallurgy," the temporary offices of which are situated at 18 Finch Lane, E.C. Its object is the general advancement of Mining and Metallurgical Science, and it comprises four classes—Honorary Members, Members, Associates, and Students. With exception of the Honorary Members, all must be engaged in practical Mining or Metallurgical pursuits, or be about to enter the profession as students. The general plan of the new Institution corresponds with that of the Institute of Civil Engineers, and it is intended that it should take a corresponding position so far as concerns mining engineers. A number of the Associates of the old Royal School of Mines have joined this new body, one of them, Mr. George Seymour, M.Inst.C.E., has been chosen President, while Professor A. K. Huntington, Mr. Edward Riley (long associated with the late Dr. Percy), and others form the Council.

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THE second Conversazione of the Royal Society was held on the 15th June. The exhibits included many illustrative of Natural Science. Perhaps the most interesting of these were the rats and rabbits of Professor Romanes, which showed the results of crossing various breeds. The experiments made "prove the error of those writers who assume that an act of fertilisation consists in the male and female elements intimately blending together, after the manner of a mere mechanical mixture, so that the offspring always presents characters more or less intermediate between those of its parents. In many cases this does happen, but in many other cases the admixture of hereditary elements is by no means intimate—those derived from the father and mother appearing to remain respectively grouped together," with the result that the offspring show a strong resemblance to one or other of the parents alone. Professor Seeley showed the skeleton of *Cynognathus crateronotus*, a new theriodont reptile from the Karroo Rocks of South Africa. The special nterest of the animal consists in the remarkable mammalian type of parts of its' osteology. Dr. Hicks exhibited the mammoth remains recently found in the north-west of London. Mr. Cunningham's specimens and apparatus used in the experiments on the artificial pigmentation of the lower side of flat-fishes (see NATURAL SCIENCE, p. 191), were shown by the Marine Biological Station. The remarkable non-venomous South African Snake (*Dasypeltis scabra*), whose food consists entirely of eggs, was exhibited by the Zoological Society. The egg is unharmed in the mouth of this snake; but by the muscular contraction of the gullet it is forced against and cut open by a saw-like row of gular teeth, which are formed by the inferior processes of the neck vertebræ. The hard shell is rejected by the mouth in the form of a pellet. The red pigment, Turacin, containing 7 per cent. of copper, which Professor Church has recently found in the wing feathers of the *Musophagidee*, or plantain eaters, was shown. Insects were also represented by cases of Lepidoptera in illustration of mimicry, shown by Professor Stewart, and by Mr. Poulton's Photo-micrographs illustrative of the mode in which the scales have disappeared from the transparent wings of certain moths. Of the botanical

exhibits, the *Lodoicea seychellarum* or double cocoa-nut was sent from Kew; *Splachnidium rugosum*, Grev., the type of Misses Mitchell and Whitting's new order of algæ, was exhibited by Mr. Murray; while Professor Marshall Ward showed preparations of various botanical objects, chiefly fungi, which cause diseases and injuries in plants. Mr. Savile Kent sent some photographs of coral reefs, and the marine fauna of the Great Barrier Reef of Australia.

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THE Annual Report of the Lausanne Natural History Museum for 1891 has just been published. The chief accessions recorded are a fine collection of Triassic fossils, formed by Professor Renevier at Hallstadt, the collection of European land and freshwater shells belonging to the late Gustave Maillard, a collection of algæ from Finisterre, from M. Chenevière, and some freshwater algæ from Department Manche from Mlle. Richard. The Report shows that this museum maintains its steady progress, mainly owing to its energetic keeper, Professor Renevier.

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THE programme of the International Botanical Congress, to be held at Genoa next September, is as follows:—

Sunday, Sept. 4.—8 p.m. Reception of Foreign Botanists in the Municipal Hall.

Monday, Sept. 5.—9.30 a.m. Inauguration of the Congress in the Great Hall of the University. 2 p.m. First Scientific Session (Great Hall).

Tuesday, Sept. 6.—10 a.m. Inauguration of the Hanbury Institute (Botanical Garden). 2 p.m. Second Scientific Session (Great Hall).

Wednesday, Sept. 7.—9 a.m. Third Scientific Session (Great Hall). 2 p.m. Visit to the Exhibition and Town.

Thursday, Sept. 8.—8 a.m. Sea trip to Portofino, thence by carriage to S. Margherite, Rapallo, Ruta and Recco, returning by steamer.

Friday, Sept. 9.—9 a.m. Fourth Scientific Session (Great Hall). 2 p.m. Fifth ditto.

Saturday, Sept. 10.—7 a.m. Excursion to Ventimiglia and Mortola, and visit to Mr. Thomas Hanbury's garden.

Sunday, Sept. 11.—Excursion from Ventimiglia to the Col di Tenda.

The duration of the Congress may be prolonged if deemed advisable. Anybody "occupied in botanical study or cultivating any special branch of botany" will be entitled to take part. To be inscribed as a member, a printed form distributed for the purpose must be signed and forwarded to the Organising Secretary, Professor O. Penzig, R. Université, Genoa, or a book provided for the purpose may be signed during the Congress. Every member, except those who are members of the Italian Botanical Society, will pay a fee of ten francs on receiving his admission card. This card admits to all the sittings of the Congress, and to the museums, libraries, and collections, which will then be open to the members, and also gives the right to take part in the excursions and entertainments proposed. All the sittings will be held in public, but the right to speak and take part in the discussions is reserved for members. The official language will be Italian, but everyone will be free, when speaking or in discussions, to use the language with which he may be most familiar. No particular subdivisions of the various branches of botany will be instituted, with separate meetings for each, unless the number of members present and the abundance of subjects to be discussed should render this necessary. No special subjects have been fixed for discussion, but "the Reform of Botanical Nomenclature will be treated in accordance with O. Kuntze's recent book"; lectures are also announced on F. Delpino's theories on Phyllotaxis and Pseudanthis. Notices of subjects for discussion must be sent to the Secretary not later than August 15. After the Congress the Committee will print a brief account of the meetings, together with the original memoirs presented; each member of the Congress will be entitled gratis to a copy of these "Proceedings," while authors of the memoirs will receive gratis fifty separate copies. The Congress will take place in the Palace of the Royal University (Via Balbi). Arrangements have been made with the Italian and foreign railway companies and the chief Steam Navigation Companies, so as to obtain the usual reduction of fares for members of the Congress. An office where information concerning lodgings can be obtained will be opened at the Municipality of Genoa.

# OBITUARY.

## JOSEPH MARTIN.

THE death of this enthusiastic explorer was announced on May 26, at Marghilan in Russo-Turkestan. Mr. Martin, who succumbed to an illness brought on by privation and fatigue, has added much of late years to our knowledge of Central Asia, having traversed Thibet and the country bordering the southern frontier of China. He was a somewhat wealthy man, and devoted the major part of his money to exploration.

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A REPORT of the death of Emin Pasha has been circulated, but so far, there is nothing to show that this is more than one of the rumours which all African travellers have to put up with. It has received the inevitable contradiction, which is probably as reliable as the original statement.

# OBSERVATIONS AND CORRESPONDENCE.

## PRE-GLACIAL MAN IN BRITAIN.

In reference to our observations on this subject in the April number (*supra*, p. 85), Mr. W. J. Lewis Abbot writes a long letter, from which we extract the essential points:—

"What can the writer mean when he says 'the discussion of man's antiquity in Britain has, by common consent, been allowed to slumber for some years'? Can he quote any seven years in which a greater store of information has been amassing in favour of man's antiquity than the last? The next sentence is ambiguous, namely, that the evidence 'was scarcely such as to command the respect of geologists,' and joined to this is the assertion that 'it seemed also probable that before long facts would be discovered that would definitely settle the question.' What are these facts? and upon what is their probable discovery based? The writer goes on to say that 'many weak links exist in the chain of argument by which he [Professor Prestwich] attempts to prove that man existed in this country prior to the denudation of the Thames Valley and the Weald.' Why are not some of these 'weak links' enumerated? One would say that no geologist or anthropologist would question the priority of the plateau men. The writer objects that 'many of the supposed flakes yield but doubtful evidence of human agency, and none of them have yet been found more than 2½ feet below the surface.' With regard to the first statement, the flakes, although apparently so asymmetrical, show a persistency of type, an identity of curvature, not to be excelled by river-drift specimens; while as for the depth at which they are found the plateau drift is rarely penetrated deeper, under conditions where one could find implements."